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MARCH, 1983

THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

Semi-Automatic Pipe Handling System And Fabrication Facility Phase II - Implementation

U.S. Department of Transportation
Maritime Administration

in cooperation with
Avondale Shipyards, Inc.
New Orleans, Louisiana

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FOREWORD

The primary objective of this project was to design, install and evaluate an integrated semi-automatic pipe shop for the manufacture and assembly of shipboard piping systems. This facility will reduce the labor, material handling required and increase the flow through the system for a given space requirement and provide for storage as well as fabrication area. The project was conducted in such a way as to provide full viability to all U. S. shipyards during the design, installation. and evaluation phases. This was accomplished through Avondale's (ASI) interaction with Panel SP-1 of the Ship Production Committee as part of the National Shipbuilding Research Program.

The magnitude of this project required subdividing the total project into sub-projects functionally oriented. During the project any one of the sub-projects could be developed independent of the other in respect to function, equipment, design or selection. Attention was given to sub-project interface to assure total project integration.

The facility has been designed to handle 1-1/2 inch through 24 inch diameter pipe and all ASTM Class and schedules and alloys of pipe used in shipboard systems. The facility is versatile and equipped to handle repair jobs and specialty items, as well as new vessel piping systems.

Our technical approach of this project fulfilled the stated objectives of the National Shipbuilding Research Program as established under the Merchant Marine Act of 1970.

RESULTS OF PHASE I

We have determined the state of the art by site interviews with knowledgeable individuals in other shipyards and industries both foreign and domestic. Further, we have conducted a search of literature and have corresponded with selected technical societies during Phase I, “Feasibility Study” of this project, as outlined in the Final Report issued in April 1978.

SOFTWARE

The term software in this project pertains to the shop control and management programs as explained within the requirements report computer software system for a semi-automatic pipe handling and fabrication facility dated May 1980.

TECHNICAL APPROACH - PHASE II - FINAL DESIGN

1. Final facility layout showing actual installation locations of work stations, machine and equipment location, conveying system, routing, has been developed.

2. A contract was let to an established consultant or system supplier for system coordination with functional responsibility for the overall system integration.

3. Final flow process charts showing pipe flow through the facility detailing the actual process through each work station were prepared.

4. Final machine design drawings are completed.

5. Fabrication of prototype machines has been completed.

6. Final purchased equipment and machine listing were developed.

7. Final installation Phasing Plans were developed.

TECHNICAL APPROACH - PHASE II - INSTALLATION AND CHECK-OUT

1. Installation of equipment and machines per the final installation phasing plan. The phasing plan was based on non-interference, allowing production to continue during the facility modernization, rearrangement and installation efforts. All equipment and machines were rearranged and/or installed in the existing pipe fabrication building with certain modifications.

2. The facility was completely checked out assuring that each item of equipment and machinery performs within the design criteria.

3. All processes requiring certification procedures are so certified.

4. Time studies were made to substantiate our findings and compare systems and determine cost.

FINAL RESULTS AND REPORTS

At the conclusion of this project, a summary of the data collected was made and an oral and written report of the results presented.

FACILITY DEMONSTRATION

The complete facility has been open for visitors from all shipyards, etc. The formal facility demonstration was held in June 1981 in conjunction with the Ship Production Committee meeting at Avondale Shipyards, Inc. The facility is fully activated producing production pipe assemblies in support of Avondale Shipyards, Inc.

ACKNOWLEDGEMENTS

The author and contributing editor is R. A. Price who serves Avondale Shipyards, Inc. as MarAd Research and Development Program Manager Facilities.

Appreciation is expressed to Mr. G. Wilkens of Oxytechnik who furnished essential support. Appreciation is also expressed to Conrac Corporation of California and Schwarze-Wirtz of Germany.

The semi-automatic pipe handling system and fabrication facility is an end product of one of the many projects managed and cost shared by Avondale for the National shipbuilding Research Program. The program is a cooperative effort by the Maritime Administration and the U. S. Shipbuilding Industry. The objective, described by the Ship Production Committee of the Society of Naval Architects and Marine Engineers, is to improve productivity.

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1.0 FUNCTIONAL DESCRIPTION

Avondale Shipyards has constructed a semi-automatic pipe handling and fabricating facility which is, considered by some, to be the most advanced of its kind in the world. This shop is designed to handle pipe sizes ranging from 1-1/2 inches through 24 inches, and in multiplicity of alloys and schedules, the facility is applicable to the efficient fabrication of pipe assemblies used in such industries, power generation, the off-shore oil and gas production industries and many others who have requirements for prefabricated configurations of pipe.

The economics of a semi-automatic pipe fabricating facility are readily justified. For example, in the shipbuilding industry alone fabricated piping costs amount to approximately one-fourth of the total hull costs of a ship.

A study conducted by Avondale Shipyards indicated that, through automation, the manhours could be reduced by 39.8% per shipset. In addition to the reduction in manhours, the rate of fabrication could be accelerated to provide a more rapid delivery of the completed items to the job site.

The same advantages to be found in shipbuilding can be gained by others in industry where there is a definite need for quick delivery of piping assemblies at a reasonable cost. With the semi-automatic pipe fabricating facility, it is entirely possible for a client to place an order for pipe assembly one day and to pick up the completed job the following day.

The basic concept of the new facility is to produce an integrated processing line employing the most efficient concepts in automation. In its planning, the major emphasis has been on the welding and a handling system that minimizes the use of cranes. The aspects of not only saving manhours but also standardizing fabrication methods, improving fabrication precision and achieving centralized control of scheduling and material handling have been considered.

Prior to the design of the Pipe Shop, Avondale engineers and production personnel visited numerous pipe fabrications plants in Japan, throughout Europe, and in the United States. Nowhere did they find the degree of automation they desired. Although one plant would have a modern conveyor system, a highly sophisticated storage method, or an automated welding line, they did not carry the principals of automation far enough. It was the conclusion of this team that there was not a single total automatic, or semi-automatic, pipe fabricating system available in the world. Yet, most of the machines required for such a system were available in Europe, Japan or the United States.

On this basis, it was up to Avondale Shipyards, working with its own technical personnel and numerous vendors of equipment, to develop a system and to initiate the manufacture or modification of existing machinery to make the proposed Pipe Shop the most cost effective semi-automatic pipe handling and fabricating facility in the United States.

The production line begins with a storage and selector system wherein the pipe in sizes ranging from 1-1/2 inches through 24 inches, of various wall thickness and to ASTM, MIL-Spec or alloy are stored. From the storage area an operator can select a particular pipe from the rack and, by means of an automatic feed system, load the pipe onto the conveyor and deliver it to the particular work station. By-passes are incorporated so that work stations not "required may be circumvented. The entire operation - selecting, loading and moving raw materials to the work stations - is all pushbutton controlled. Further, the automatic conveying system for the movement of pipe from one work station to another is equipped at each station with an automatic unloading device and a reserve area.

A semi-automatic internal and external surface preparation system for pipe has been installed to service the work piece prior to starting the fabrication.

The external surface is blasted using a blasting device located inside of the closed cabinet. The internal side of the pipe is cleaned automatically in a closed cabinet through the use of shotblasting lance.

For internal coating, the pipe is positioned inside of the spray booth. The lance travels through the pipe and, under control of a limit switch, spraying starts automatically. For the application of the various types of coatings, the lance

travel speed is matched to the spray system with variable pre-select pushbutton controls. After the lance passes through the work piece, spraying starts as the lance is backed out.

The external coating process starts automatically; spraying is again an automatic process as the pipe is carried through the spray booth. If internal coating of the pipe is not required, the process may be by-passed.

Cutting and end preparation machines are the next operation on the automatic production line. This function is extremely important since, in order to obtain proper welding results, the use of machine cutting is desirable.

The various cutting machines required to process alloy mix of pipe going through the system are selected. The quantities of each type of cutting machine are controlled by the diameter and alloy range of the specific cutting machine with particular attention given to cutting speeds and quality.

Automatic loading and unloading devices are provided for each cutting machine with full pushbutton control. The usable piece of pipe is conveyed to the next work station with scrap material. dispensed with for subsequent removal.

Square cuts of 1-1/2 inch to 20 inch diameter pipe are made utilizing a saw. An automatic process which measures the pipe for cutting to length is installed in this cutting station. If a bevel is required, this is accomplished by a machine tool device. Pipe over 20 inches in diameter is cut by

the use of the plasma/gas method. The bevel can be accomplished during cutting.

Contour cutting machines are used for contour end cuts and hole cuts for branches. Where holes are to be cut, the most cost efficient production process is through the use of burning equipment.

Considerable thought has gone into the selection of the type of automatic welding equipment needed to process the mix of pipe going through the system.

For welding straight pipe, rolling devices have been supplied incorporating automatic loading and unloading mechanisms controlled by pushbuttons.

Automated welding is accomplished through manipulation of the welding gun and/or the work piece. Butt welds are made by rolling the work piece with the welding gun held in a fixed position. Branch welding for 90 degrees is accomplished by manipulating the welding gun with the work piece fixed. Branch welding 45 degrees and 60 degrees is performed manually.

Automatic flange fitting and welding devices have been installed with the capability of processing the pipe mix, selecting the flange, orienting it properly, tacking it and welding it both inside and out. Incorporated into the devices is the capability to select the particular welding process required by the alloy mix of pipe going through the system.

The quantity of auto flange fitting and welding devices used depends upon the diameter range designed into the devices

and the type of flange. Each has pushbutton selectivity for the weld procedure as well as loading and unloading the station.

Three kinds of automatic welding machines are used depending upon the size and types of flanges. For steel slip-on type flanges 2 to 10 inches in diameter, a pushbutton controlled flange fitting and welding machine is used. Welding procedures are developed and qualification test complete. The process uses Gas Metal Arc, solid and flux cored wire. Flux cored wire is used in production. This device fits and tacks flanges automatically and is capable of welding 2 flanges (4 welds) simultaneously. Flux cored wire gives higher deposition rate and less spatter than solid wire.

For weld neck flanges on 2 to 10 inch diameters, a pushbutton controlled flange fitting and welding machine is used. Advance procedure qualification work was completed in Germany. This process uses gas tungsten arc root pass with cold wire feed with pulse arc capability, gas metal arc fill using solid wire with oscillation. This machine fits and welds the weld neck flanges automatically.

For steel flanges 12 to 24 inch diameters, two welding processes are employed. Submerged arc welding and gas metal arc welding using flux cored wire are utilized. This machine also employs 8′ x 8′ motorized positioner.

In these welding machines, positioning of welding torches is done manually; however, arc voltage controls are available and could be installed, if desired.

Numerically controlled bending equipment, capable of 2 diameter bending of pipe up to 8 inch diameter, with or without flanges, is installed. Bending facilities for larger pipe and extra heavy wall pipe, since it is normally a low volume item, is not sufficient to justify extensive automation. Where the demand is for large diameter pipe, either hot bending or vibratory bending may be used.

One of the most important features of the bending operation, in addition to the 2 diameter bends, is the capability of the equipment to automatically feed pre-coated pipe to be bent with the flanges previously installed.

In the assembly area various manipulators and fixtures are used so that sub-sub-assemblies, sub-assemblies and assemblies of pipe sections can be processed in the most cost effective manner. The manipulators are fitted with semi-automatic loading and unloading devices of a design capable of positioning the main body pipe sections so that fitting and welding of the various components may be accomplished effectively.

The production line also incorporates x-ray equipment and other test facilities required in order to meet the regulatory inspection and testing requirements.

In any automatic or semi-automatic operation there are the inevitable exceptions - speciality items of a configuration or volume not suitable for automatic or semi-automatic process in:. For these purposes a specialty area, an integral part of the pipe shop, has been set up so that it is accessible to the

automatic conveying system. This provides a cost effective utilization of auto cutting end preparation, bending, hole cutting, x-ray inspection, etc.

Special manipulators and machines are installed in this area to increase efficiency but, for the most part, work in this area is accomplished by hand.

When completed, fabricated pipe and specialty items are palletized and stored in a racking system, in usage order, until required for installation or for shipment to the customer.

All manhours to be saved by an automated system can be completely offset by a major increase in the engineering staff necessary to provide drawings and other necessary data in a timely manner.

Therefore, in conjunction with the production line and its automated equipment, it was necessary to develop a computer software package that has the capability of preparing detail pipe drawings. As the drawings are being prepared, the program concurrently prepares bills of material, shop production schedules, material flow schedules, cutting lists, assembly marking and bending data, machine loading schedules, routing and final disposition and delivery schedules.

This semi-automated pipe fabricating facility involves a considerable investment. The new system is designed to produce 150 pipe spools per day with a corresponding limited reduction of skilled shop manpower. Production is expected to increase

over Avondale Shipyards' existing Pipe Shop from one spool per man day to three spools per man day including blasting and coating.

An improvement in manhour costs of 39.8% is anticipated. However, with all functions of the system operating 50% to 55%, reduction in production costs is feasible.

Avondale Shipyards' approach includes the establishment of the required work stations and the development of necessary welding techniques with certified procedures. Much of this was achieved in the welding laboratory and implementation in the production areas was a constant process as these systems and procedures were being approved.

During the progress of the study, Avondale Shipyards found a specialized piece of machinery and tooling manufactured in Europe called T-Drill. This equipment is used for extrusion of branch joint collars formed directly from the parent run of tubing or pipe.

After receiving approval from the United States Navy for use of the T-Drill method for extruded branch connections, Avondale Shipyards purchased two such units and installed them in their existing Pipe Shop. They were used in the construction of two Navy auxiliary oilers at a considerable savings to both Avondale Shipyards and the customer. Estimated savings of $864,846 were realized on the two ships.

The T-Drills are now installed in the new facility and, where applicable, will be an integral part of the Pipe Shop's fabricating equipment.

Finally, it was necessary to overcome a negative attitude toward change. Fortunately, at Avondale Shipyards, the Pipe Shop personnel provided the prime stimulus in the improvement program. It is this motivation, this impetus on the part of management, the engineering staff and the production department, that was necessary to make an automated system such as this work.

2.0 MAJOR EQUIPMENT ITEMS

2.1 cost

The cost to implement the facility shown within the system sketch would require a capital investment of five million dollars dependent upon the existing shop facilities and the size, type and volume of the pipe to be processed.

With an investment of this magnitude, managment can expect at least two things: (1) a return on their investment of approximately 35.4 percent per year depending on the facility; and (2) an extremely efficient pipe fabrication shop capable of meeting required production schedules. The system is designed to produce 150 pipe spools per day, with corresponding limited reduction of skilled shop manpower.

Fabrication cost of ship piping systems is roughly equal to one fourth of the total hull cost of a ship. For a 176,000 DWT tanker, this amounts to approximately 200,000 manhours. Through automation a percentage of the required manhours can be reduced in the following functions: Handling 68 percent; Fitting 55 percent; Welding 35 percent; Cleaning 79 percent and Coating 86 percent. These percentages are based on LASH vessel construction since all basic data is applicable to this series of ships. An overall percentage reduction in fabrication manhours equates to approximately 39.8 percent per shipset.

The data collected reflects the following statistics:

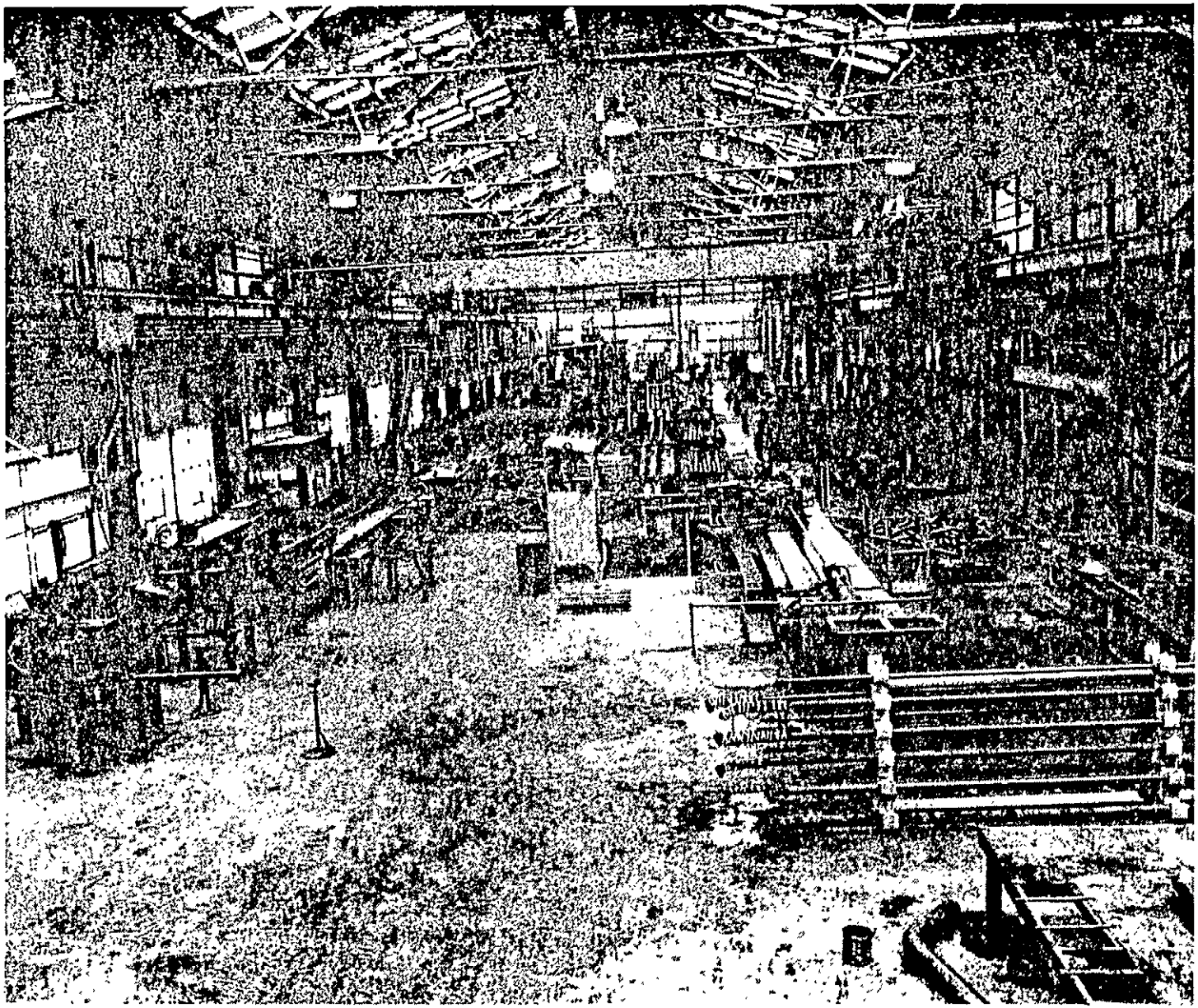
Overall System Status	
Total Pipe Spools Produced	9,613
Total Manhours Expended	50,276

	M/H Per Spool
Average Without System	9.00
Average With System	5.23
Improvement With System	3.77

Detailed System Status	M/H Per Spool
Fully Automatic Operation	
Semi-Automatic Operation	5.11
Manual Operation with Semi-Automatic Handling System	5.97

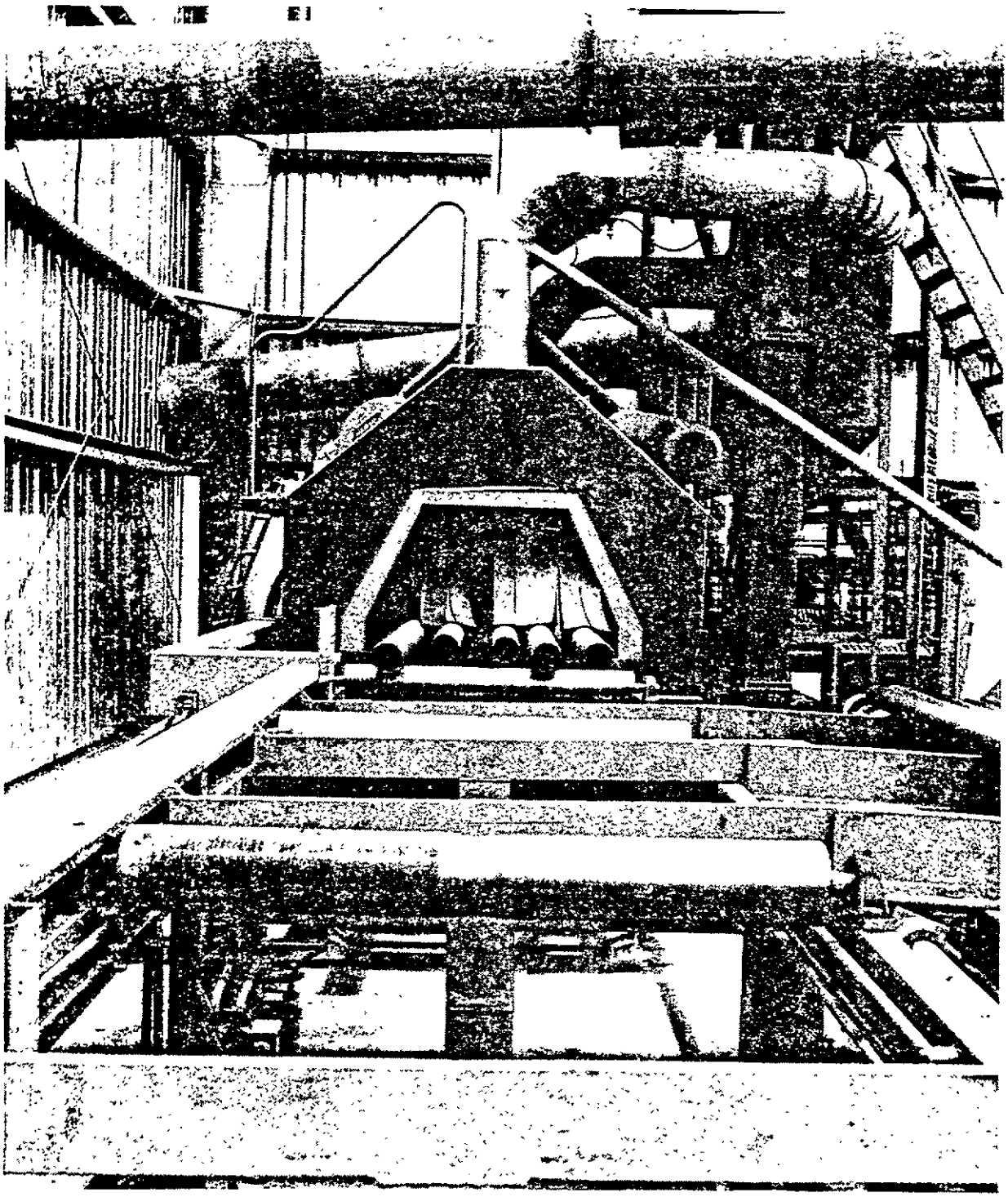
We do not feel that we have achieved the full potential of the shop. From the spool design aspect, we are able to gain experience week by week. However, we find spools designed and routed for manual operation which should have been designed and routed for automatic or semi-automatic operation.

We will continue collecting data, and through statistical analysis, experience utilizing the system, and a good work load, our improvement will definitely surpass the 41.8 percent shown.

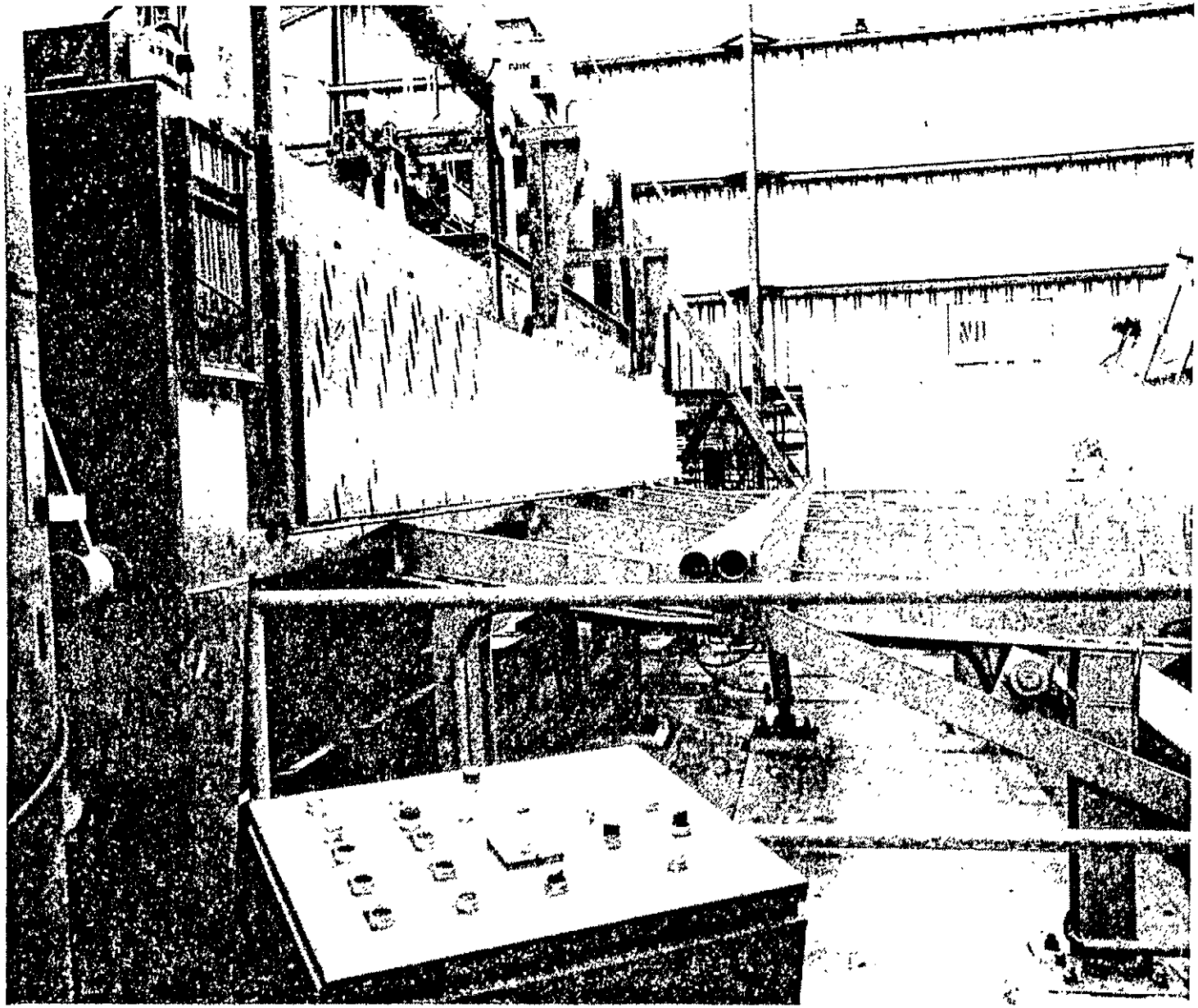


Overview - Semi-Automatic Pipe Shop

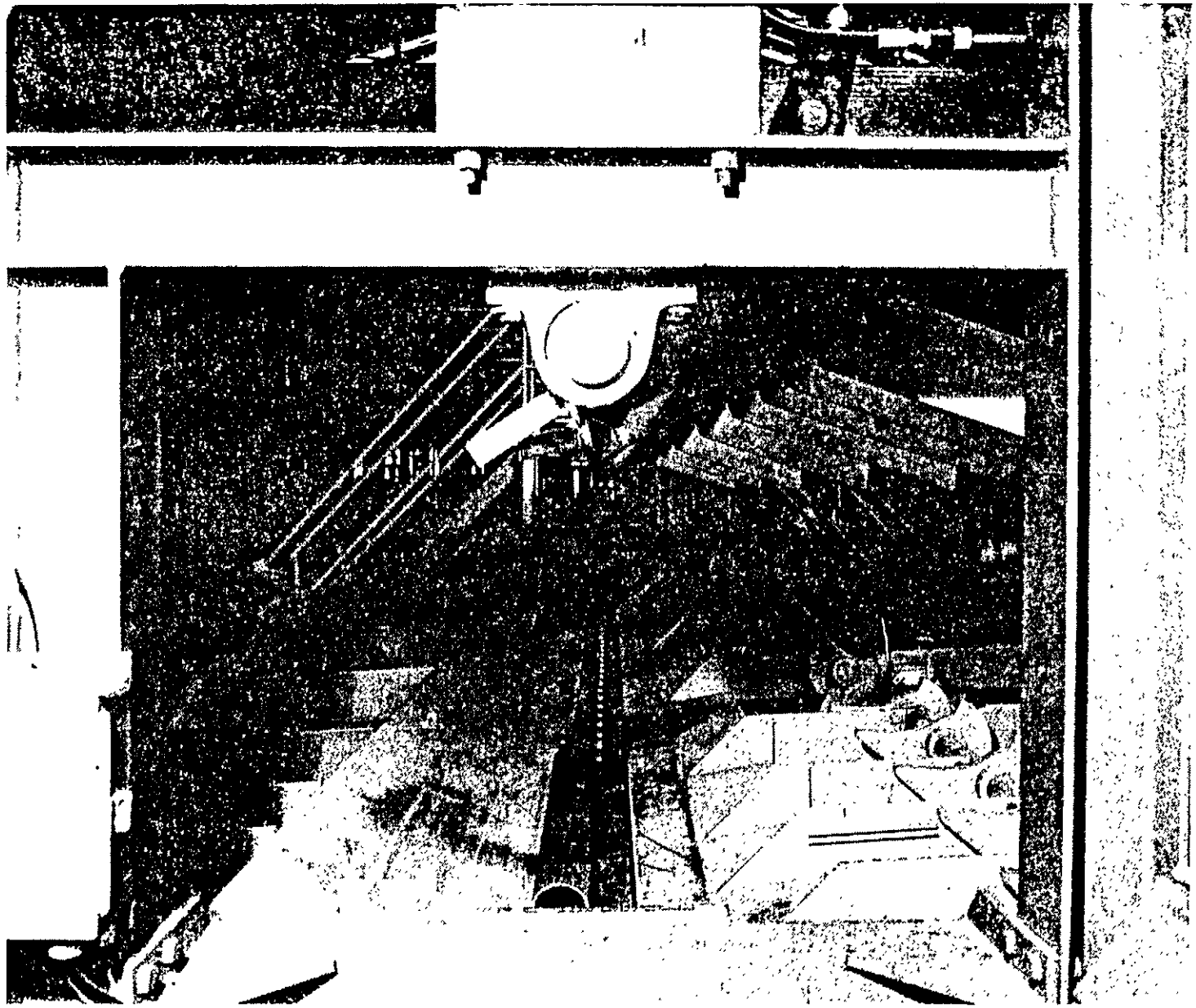
Systematic Rack Storage



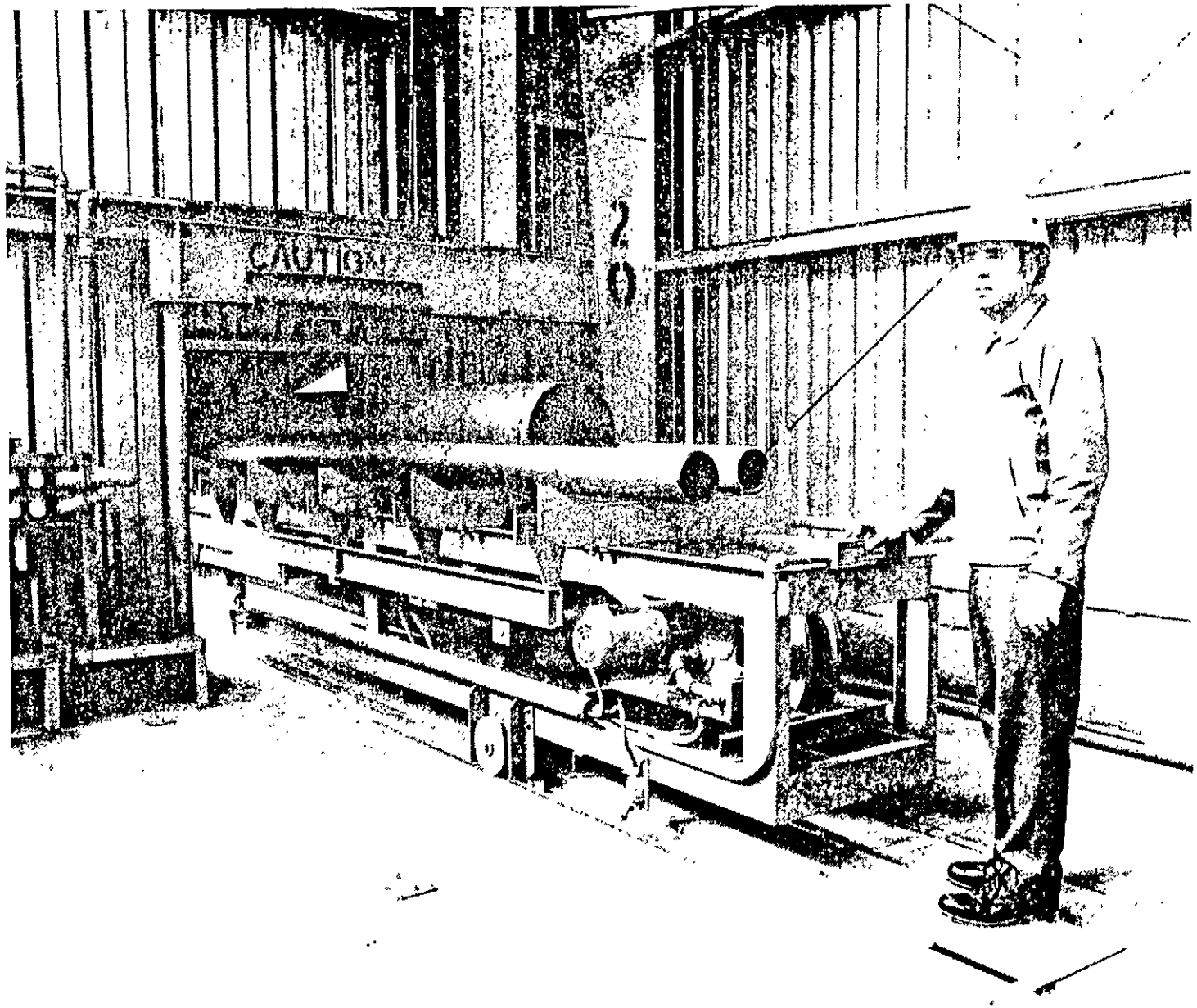
External Pipe Cleaning



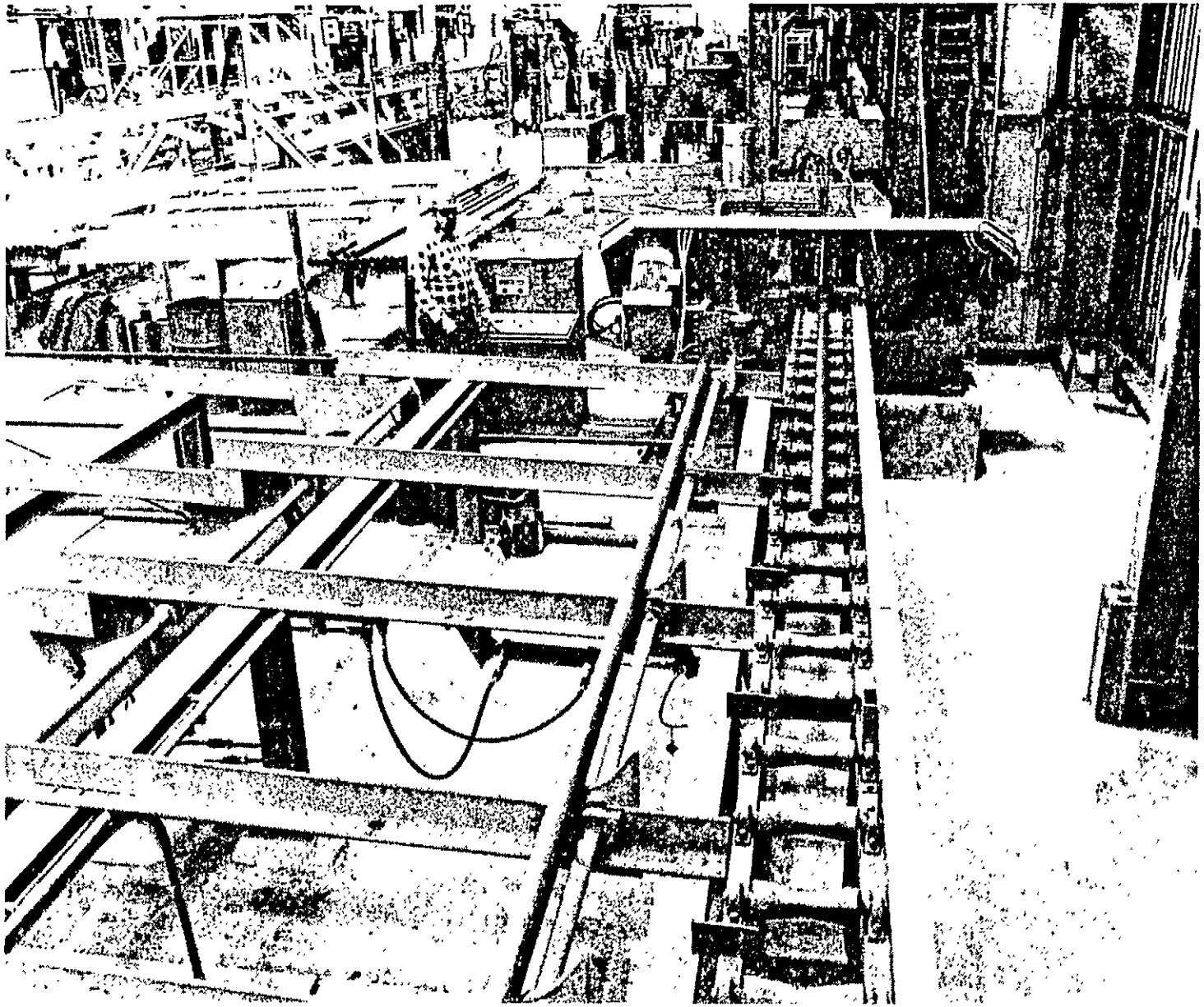
Internal Pipe Cleaning



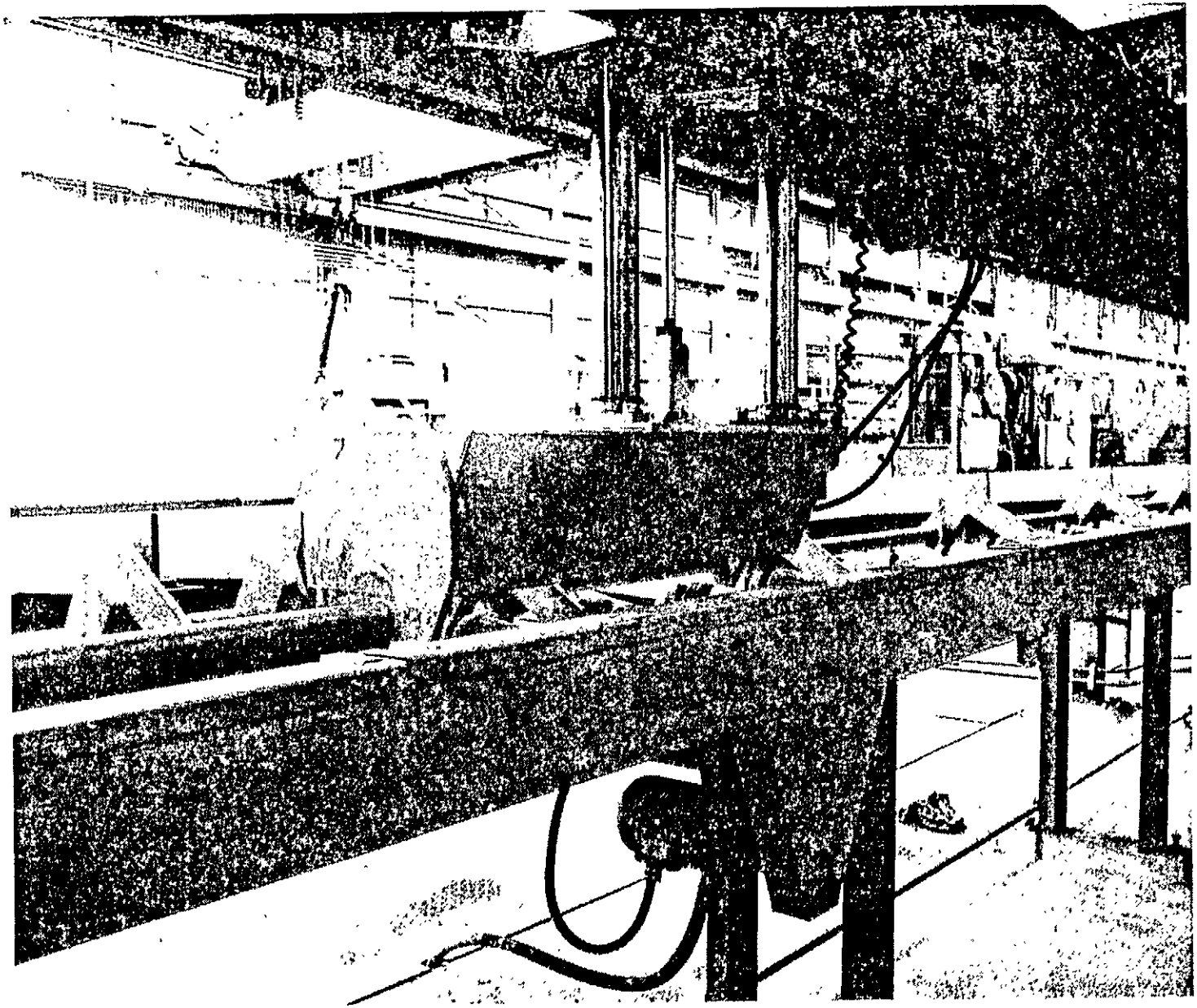
Versatile Pipe Conveyor



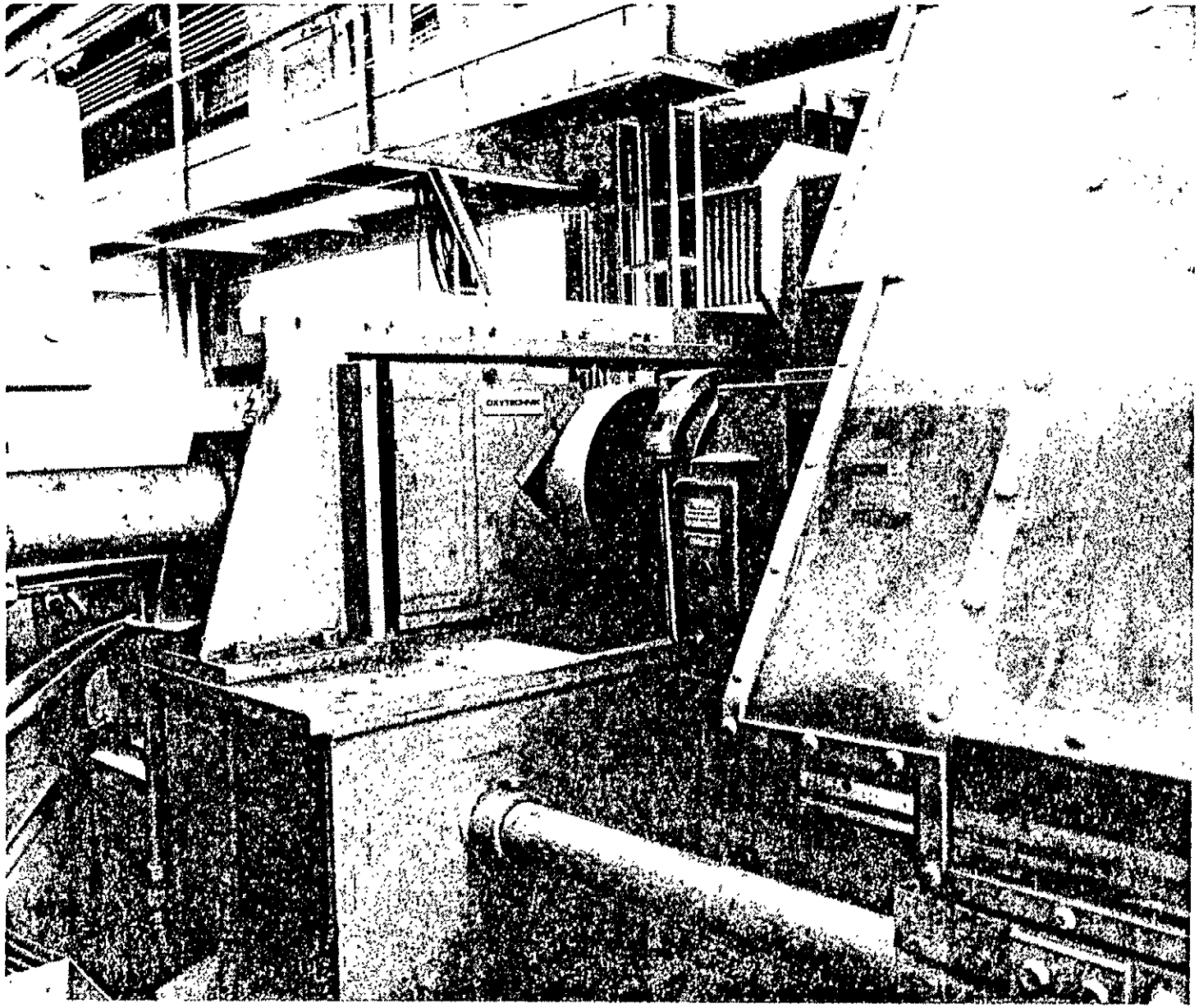
Motorized Transport Cart



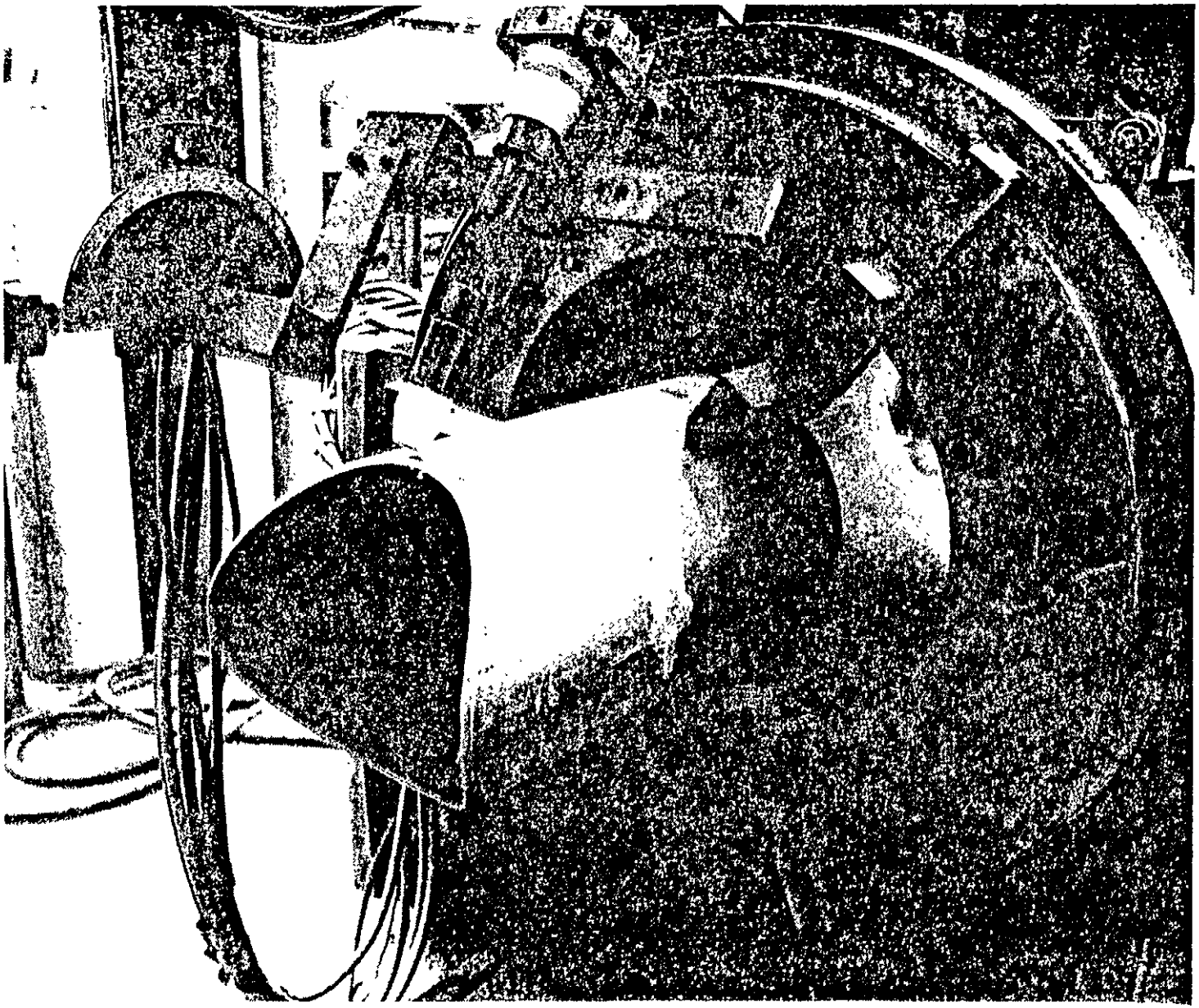
Semi-Automatic Cutting Saw



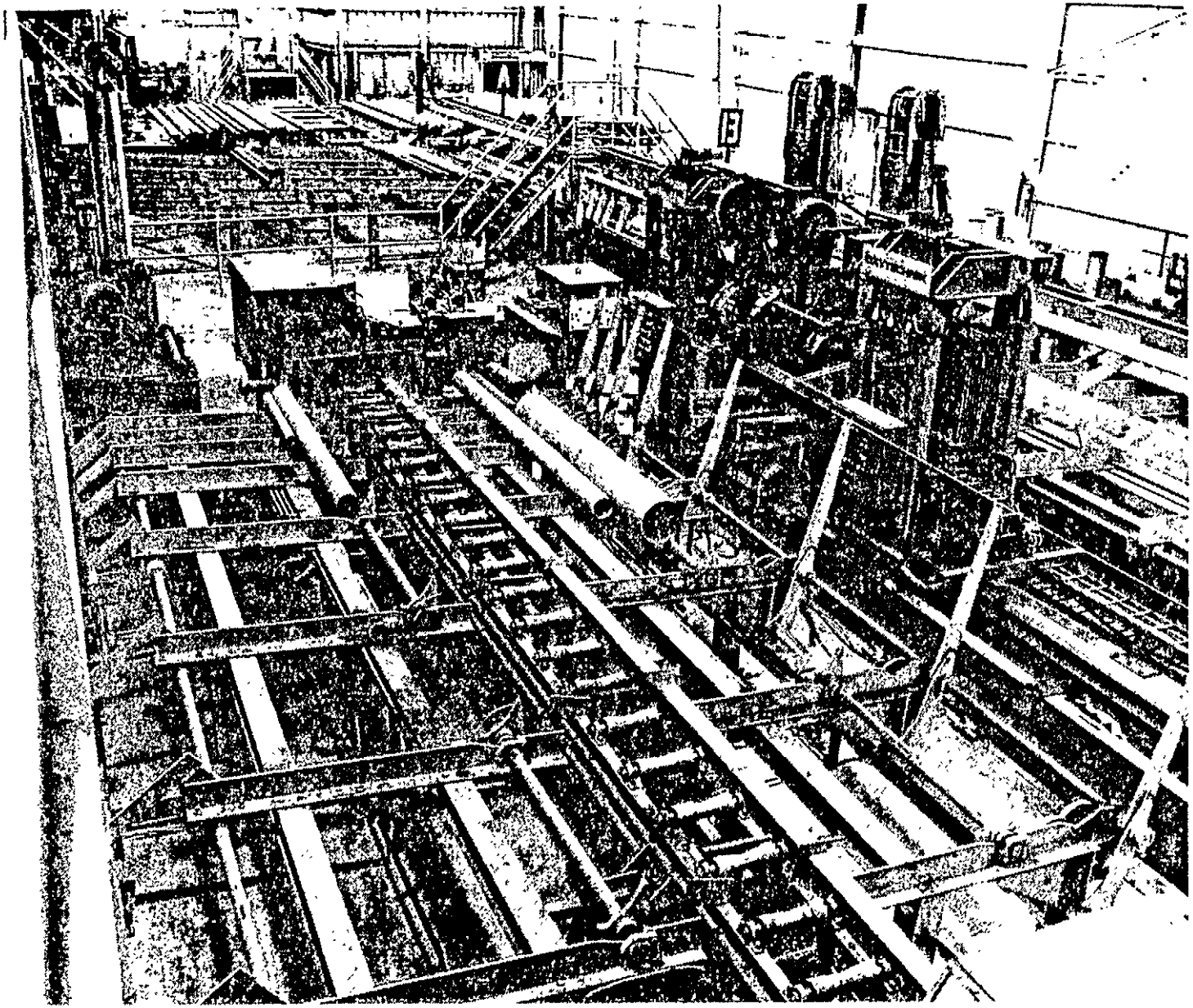
Semi-Automatic Measuring System for Cutting to Length



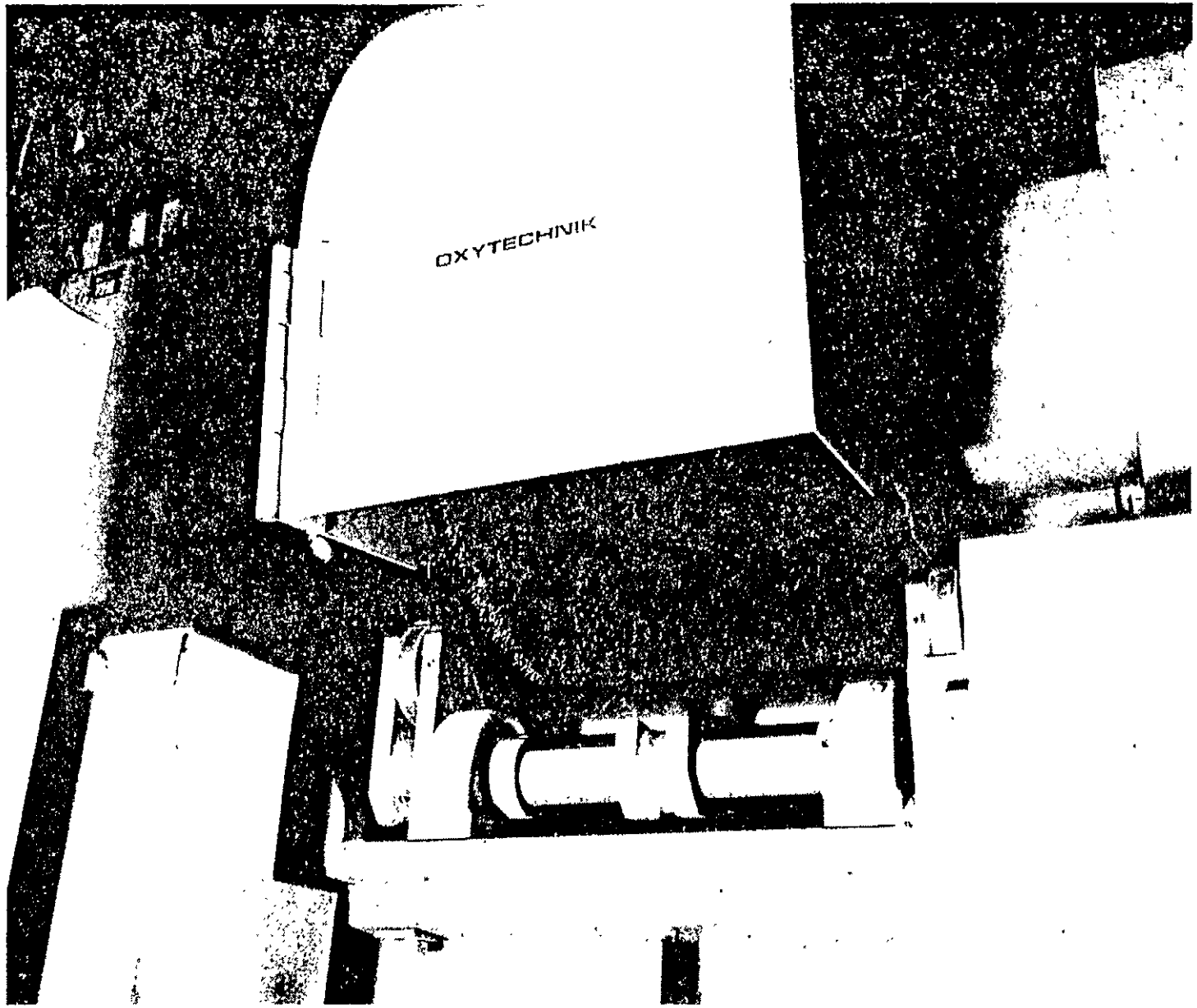
Semi-Automatic Beveling Machine



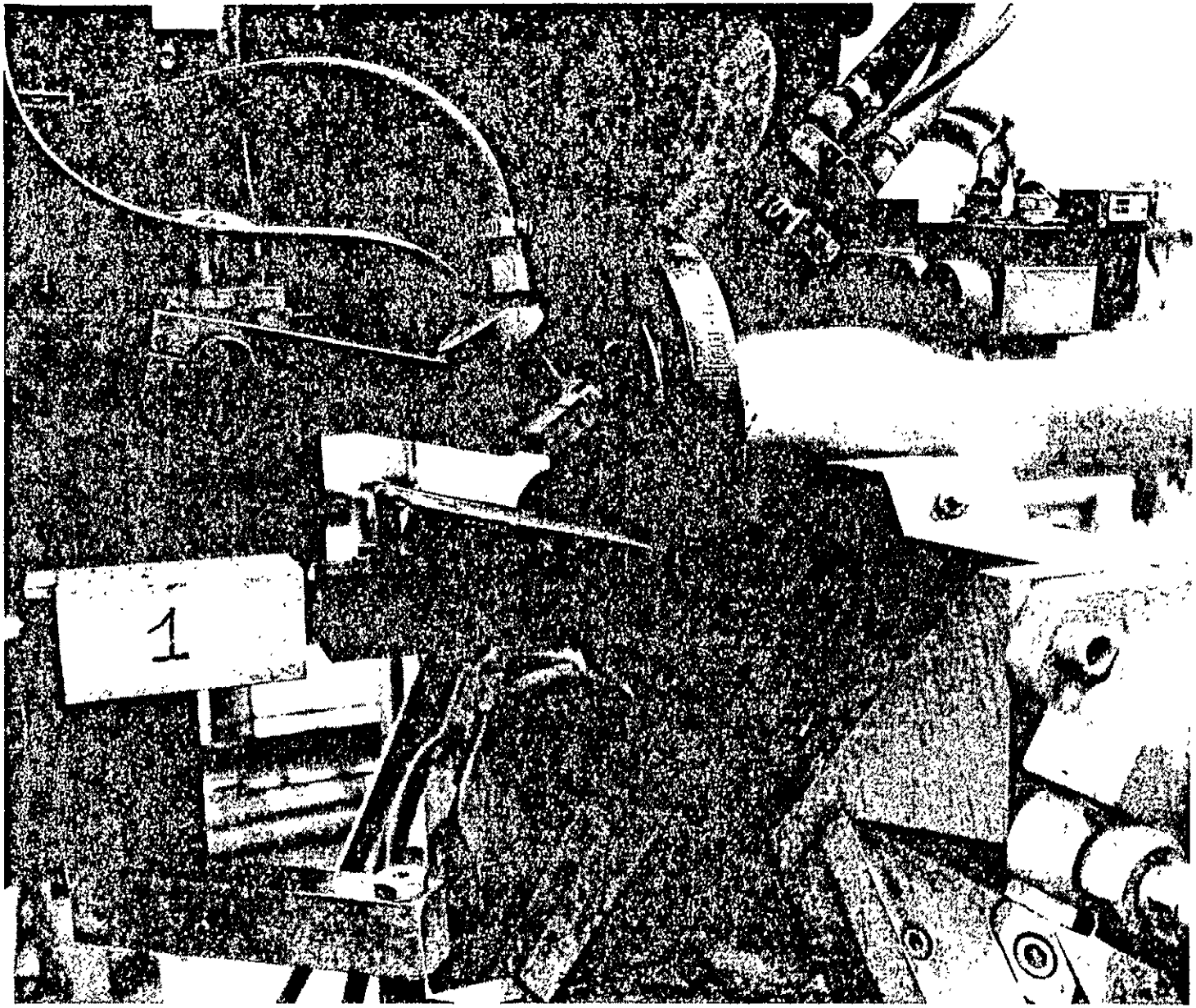
Plasma/Gas Cutting Machine



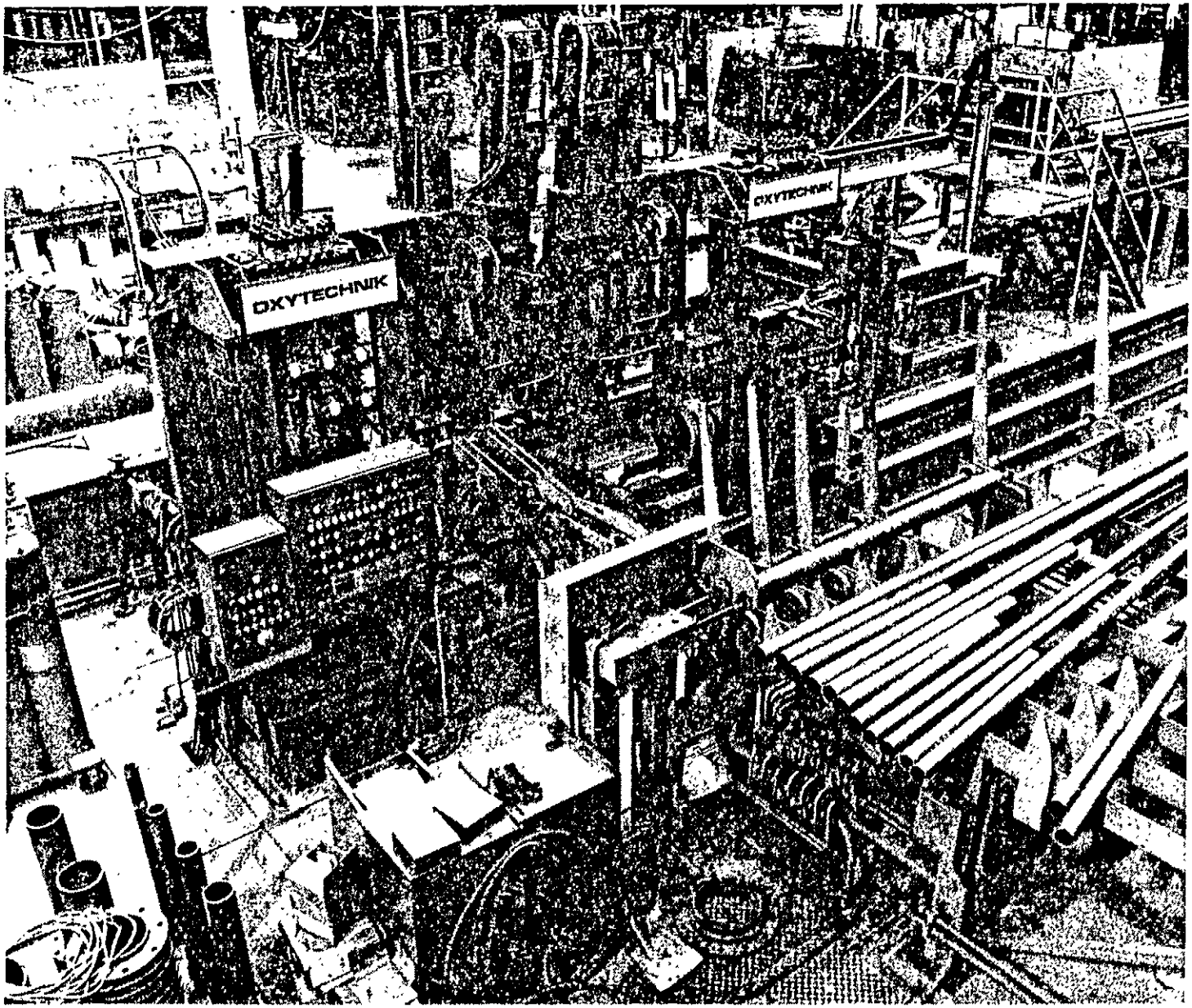
Automatic Weld Neck Flanging Machine



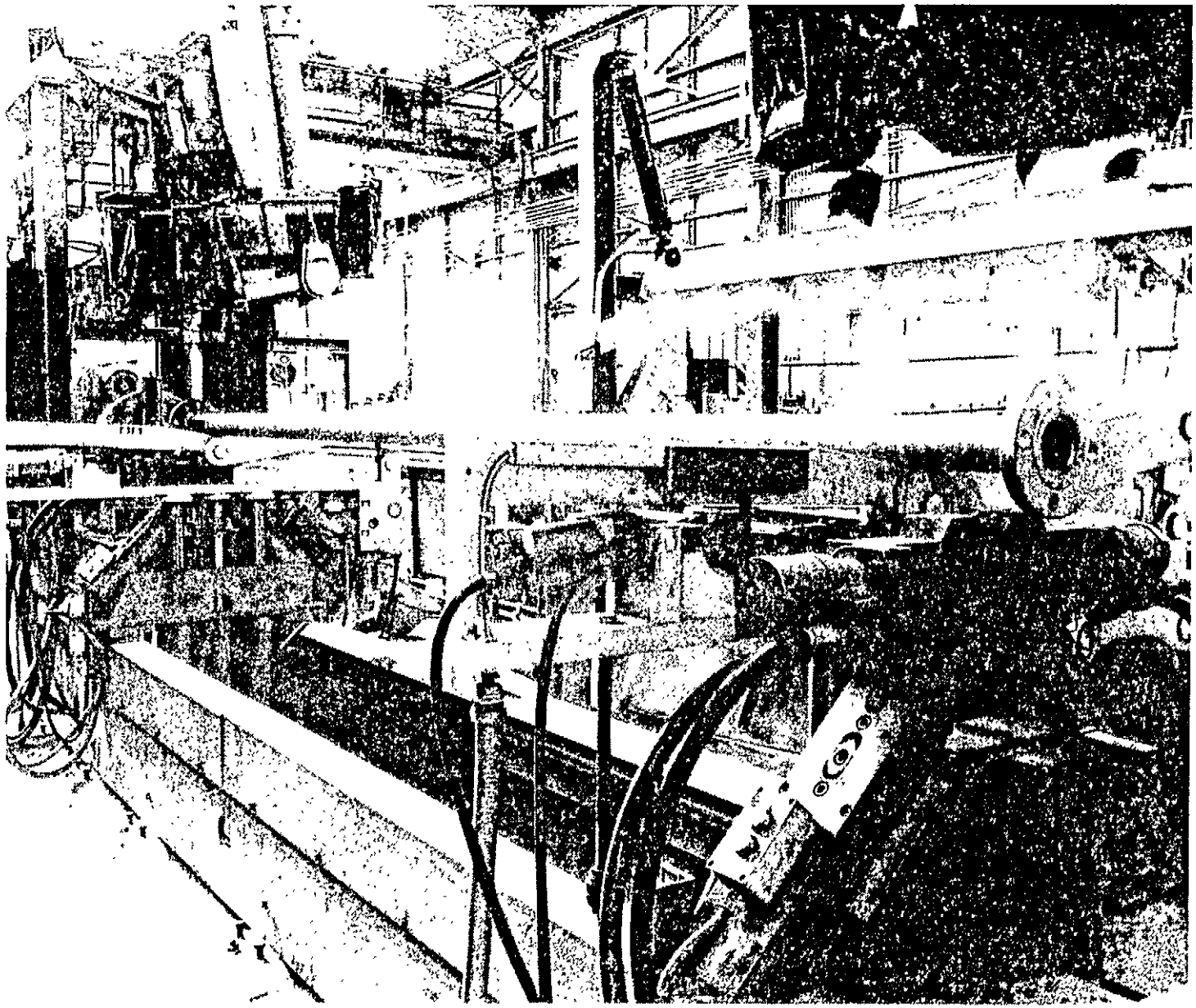
Automatic Pipe End Cleaner



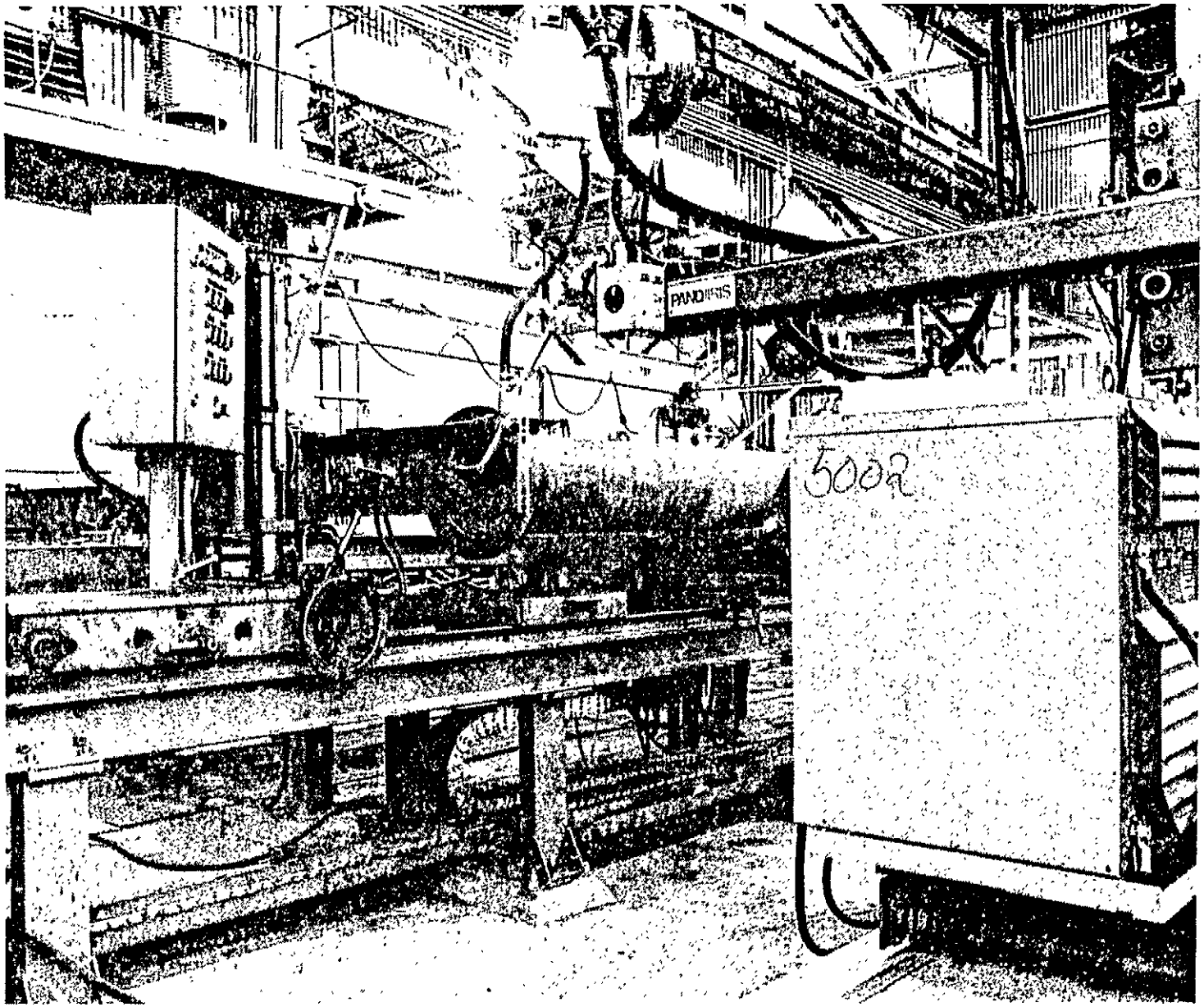
Close Up of Slip-on Flange Welding Machine



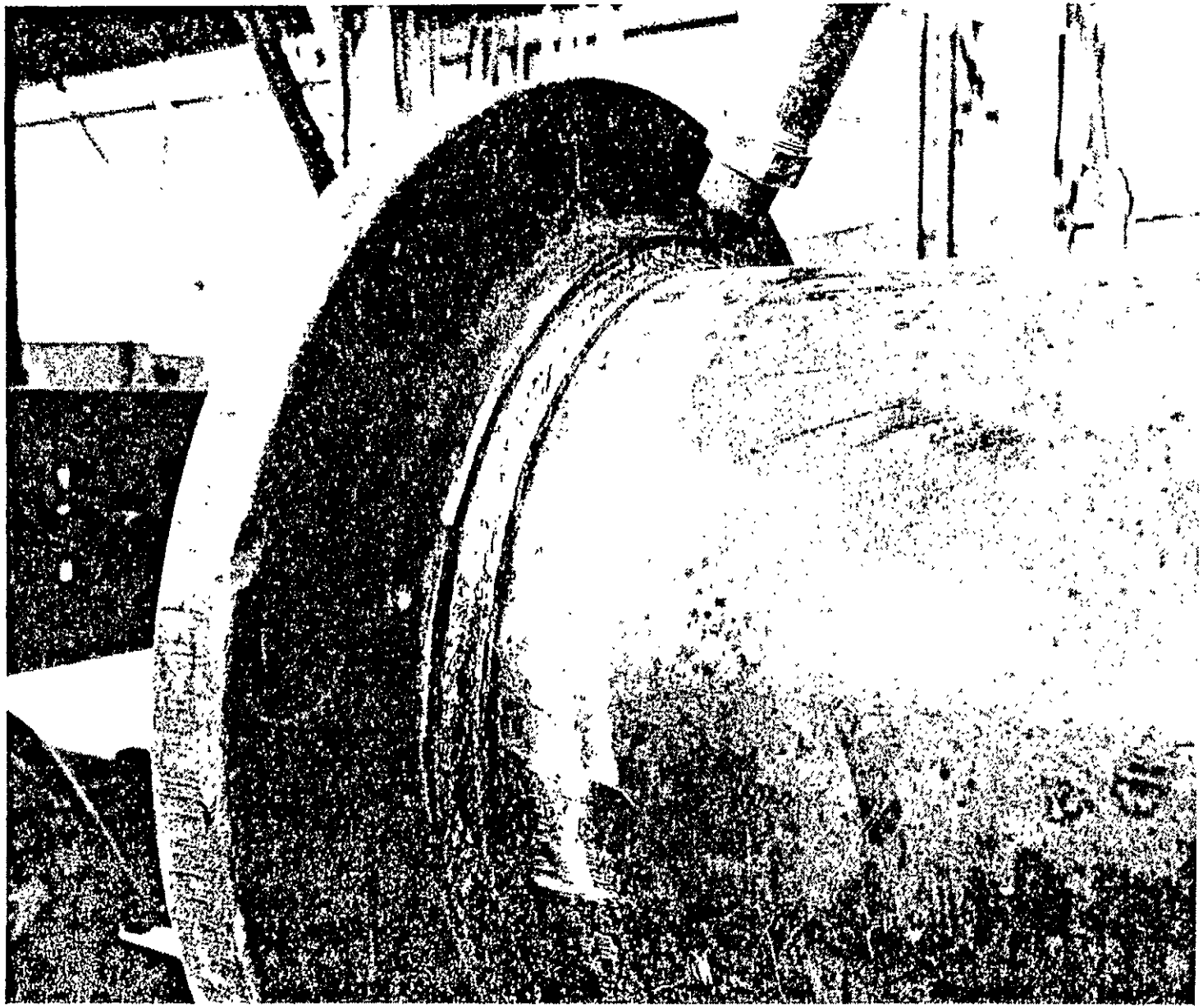
Automatic Slip-on Flanging Machine



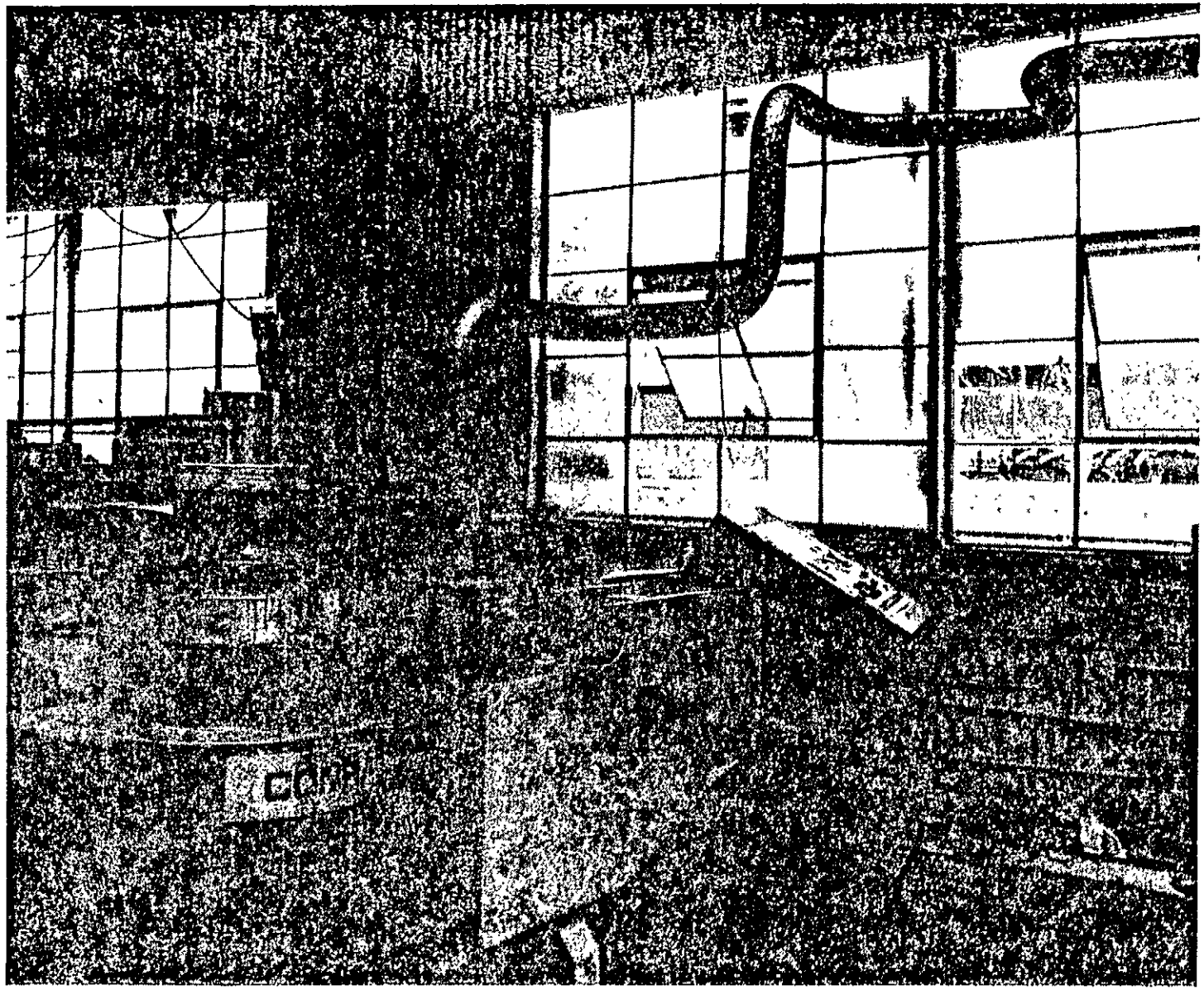
Automatic Unloading of Slip-on Flanging Machine



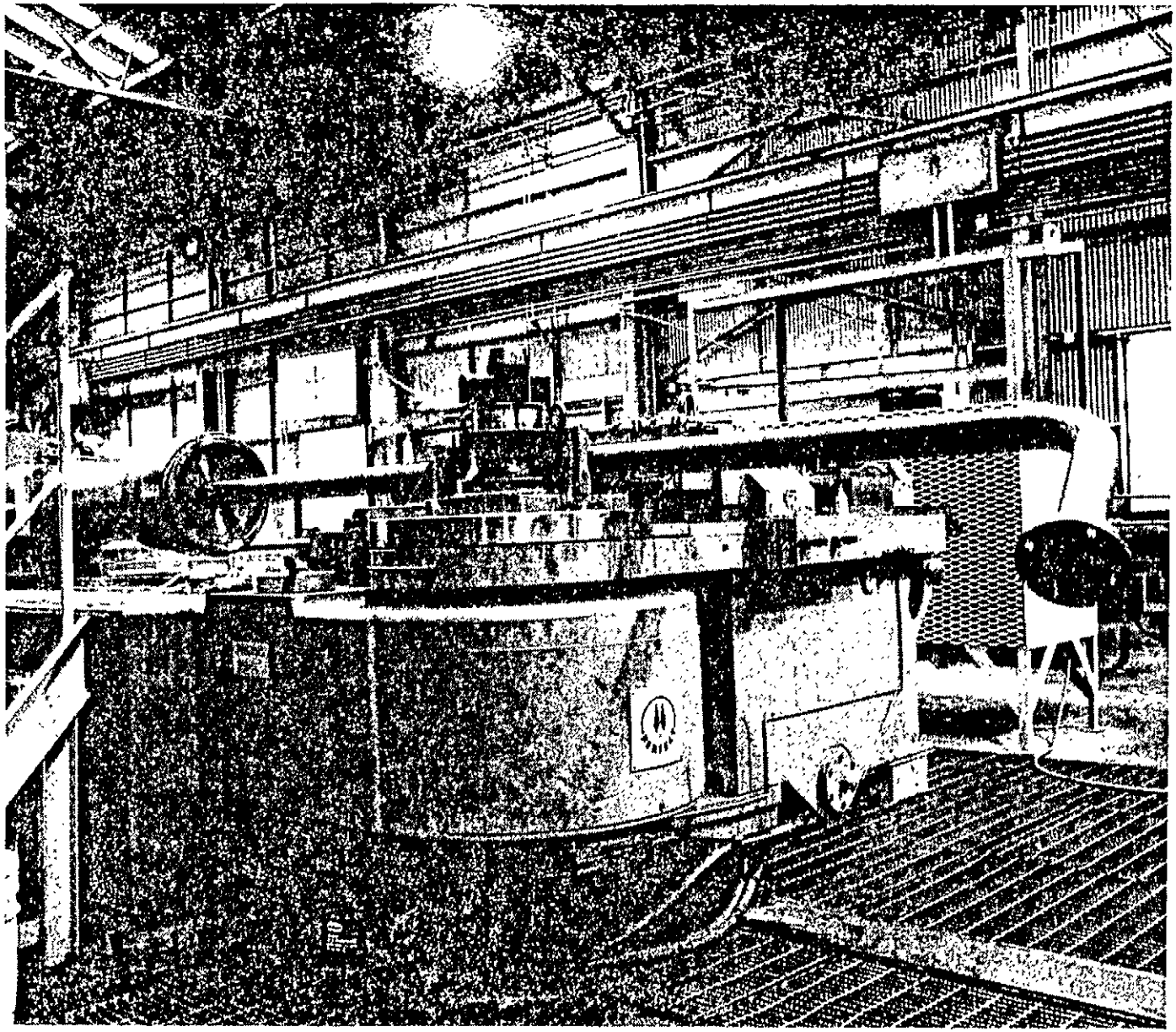
Semi-Automatic Flange Welding Machine for Large Diameter Pipe



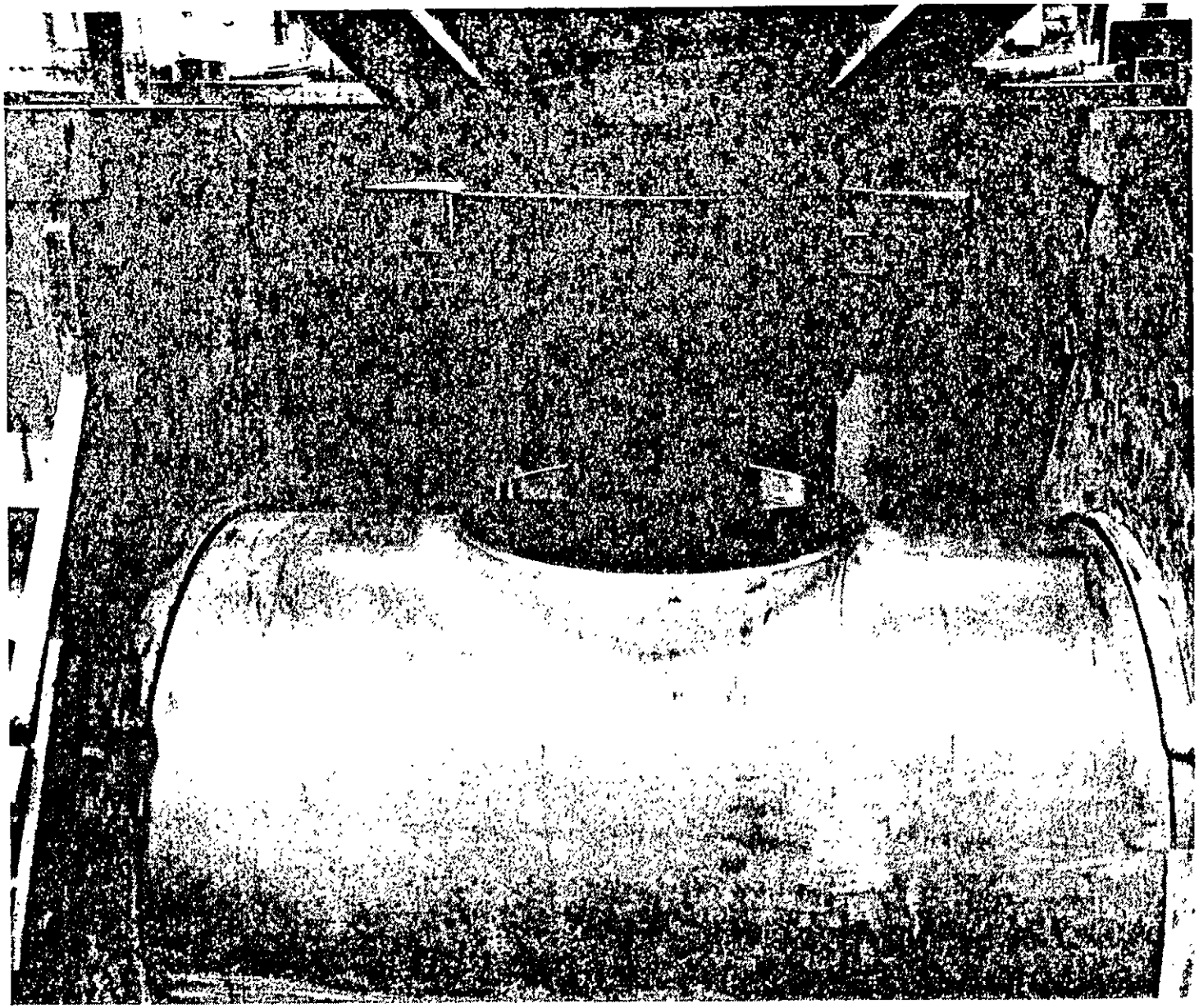
Close Up of Large Diameter Flanging Machine



Conrac CNC Bending Machine

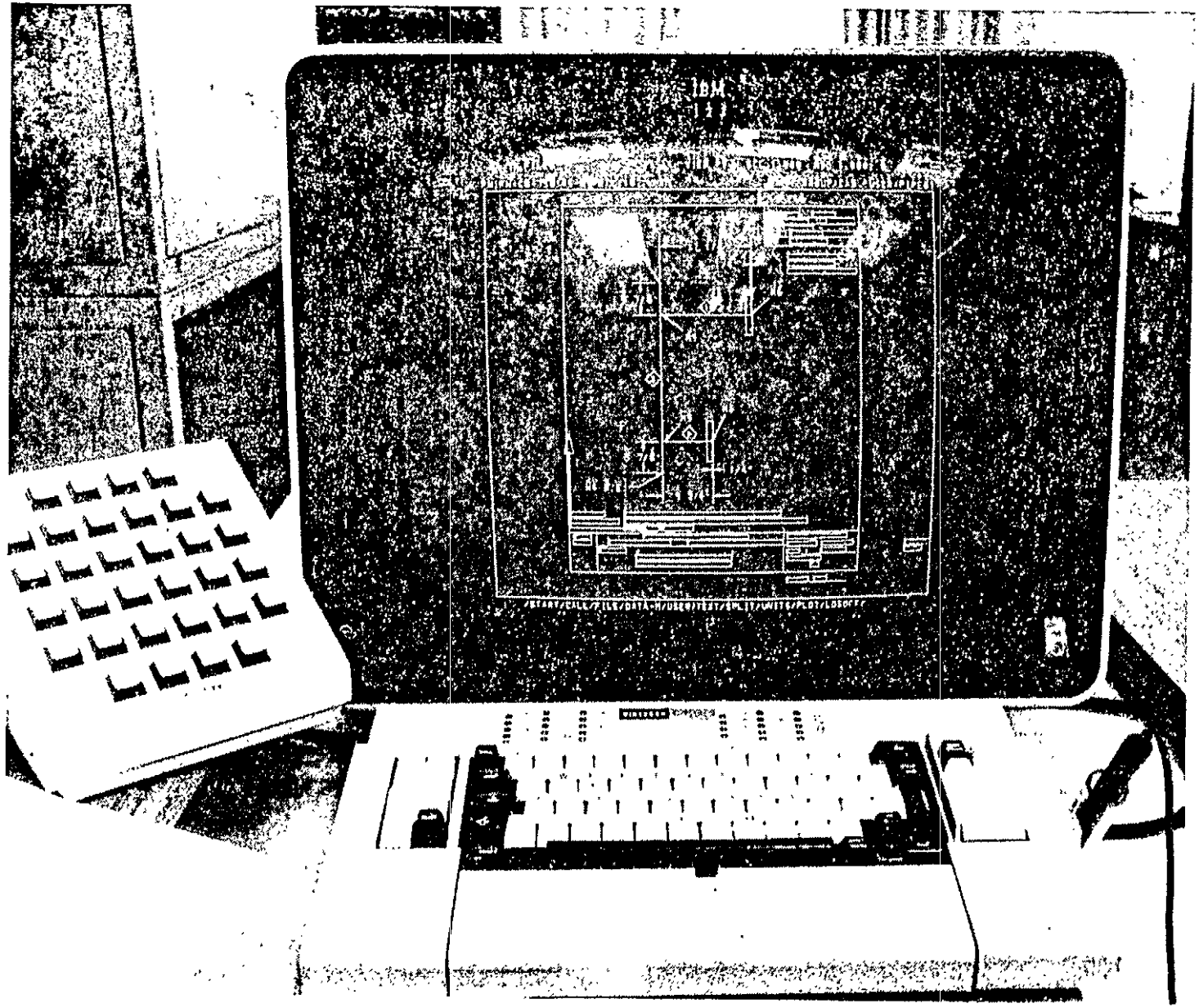


Schwarze-Wirtz CNC Bending Machine



Close Up of T-Drill 500

Semi-Automatic 90° Branch Welding Machine



CRT Used for Computer Aided Spool Design

Item 4 Bevelling Device Manufactured and Delivered by Oxytechnik

4.1 1 Bevelling Machine
4.2 1 Axial Feed Conveyor

Item 5 Electric Control Manufactured and Delivered by Oxytechnik for Control and Operation of Items 1, 2, 3, 4 and 9 as well as Drawings for Hydraulic Installation for the Above Mentioned Items.

Item 6 Flange Welder, Weld Neck Flanges, Manufactured and Delivered by Oxytechnik

Item 7 Flange Welder, Slip On Flanges, Manufactured and Delivered by Oxytechnik

Item 8 Pipe Flange Tacker and Welder with Double Rotator Manufactured and Delivered by Oxytechnik

Item 9 Plate Conveyor and Ejectors Manufactured and Delivered by Oxytechnik

9.3 1 Plate Conveyor
9.4 1 Pipe Ejector
9.5 1 Pipe Ejector
9.6 1 Pipe Ejector
9.7 1 Pipe Ejector
9.8 1 Pipe Ejector
9.9 1 Pipe Ejector

Item 10 Shotblasting and Painting Equipment (each combined exterior and interior) Delivered by Oxytechnik as well as Drawings for Roller Conveyors

10.1 Drawings for entrance roller conveyor
10.2 Drawings for exit roller conveyor
10.3 Shotblasting machine complete for external and internal cleaning
10.4 Drawings for entrance roller conveyor
10.5 Drawings for exit roller conveyor
10.6 Drawings for ejectors
10.7 Painting machine complete for external and internal painting.

General Description of Equipment

Item 1 Fabrication drawings for self-manufacturing of the following equipment:

3.0 MAJOR EQUIPMENT SPECIFICATIONS

3.1 Oxytechnik Designed Or Supplied Equipment

Technical description index for Oxytechnik Designed or Supplied Equipment.

Item 1 Fabrication Drawings for Self-Manufacturing of the Following Equipment:

1.1	1 Feed table
1.2	2 Feed tables
1.3	2 Racks
1.4	1 Feed table
1.5	1 Feed table
1.6	1 Feed table
1.7	1 Feed table
1.8	1 Feed table
1.9	1 Feed table
1.10	1 Feed table
1.11	1 Feed table
1.12	1 Feed table
1.13	1 Feed table
1.14	1 Feed table
1.15	1 Feed table
1.16	1 Feed table
1.17	1 Feed table
1.18	1 Feed table
1.19	1 Feed table
1.20	1 Feed table for short ends
1.21	1 Feed table
1.22	1 Feed table
1.23	1 Feed table
1.24	1 Pipe Transporting Cart
1.25	1 Pipe Transporting Cart
1.26	1 Pipe Transporting Cart

Item 2 Elevators Manufactured and Delivered by Oxytechnik

2.1	2 Elevators for pipe charging
2.2	2 Elevators for pipe discharging

Item 3 Measuring, Sawing and End Cleaning Line Manufactured and Delivered by Oxytechnik

3.1	1 Axial Feed Conveyor
3.2	1 Axial Feed Conveyor
3.3	1 Longitudinal Measuring Equipment
3.4	1 Axial Feed Conveyor
3.6	1 Pipe End Cleaner for Steel Pipes
3.7	1 Bend Loader for Pipes 1" up to 4"
3.8	1 Bend Loader for Pipes 4" up to 8" (10")

1.1 1 Feed Table
Designed for pipes of 14″ with 5 supports, length 13' and 1 singling out mechanism with hydraulic cylinder, total weight approx. 4410 lbs.

1.2 2 Feed Tables
Arranged in front of the racks designed for pipes 1 1/2" up *to* 12″, with double pipe stopper with hydraulic cylinder and one pipe pusher each with hydraulic cylinder, total weight approx. 11907 lbs.

1.3 2 Racks
With 11 floors each outfitted with inclined supports in rigid profile steel construction including 1800 sq. inch roof covered with asbestos-cement plates, 4600 sq. inch wall area each (2 side walls and 2 front walls) outfitted in asbestos-cement plates including mounting material, total weight apptrox. 185220 lbs.

1.4 1 Feed Table
Behind the external blasting machine with 6 inclined supports, length approx. 15′ with 1 pipe ejector, 1 pipe stopper and 1 singling-out mechanism, with 4 hydraulic cylinders, all mounted on 3 supports, total weight approx. 5500 lbs.

1.5 1 Feed Table
For charging of pipes onto the axial roller conveyor according to 9.1 with 6 inclined supports, length approx. 26′ with 1 pipe stopper and 1 singling-out mechanism and 3 hydraulic cylinders, total weight approx. 13.000 lbs.

1.6 1 Feed Table
For charging of pipes onto the axial roller conveyor according to 3.1, length approx. 17′ with 1 pipe stopper, one singling-out mechanism, 3 hydraulic cylinders, mounted on rigid profile steel support, total weight approx. 6000 lbs.

1.7 1 Feed Table
For transverse feeding of cut pipes to the plate conveyor 9.3, length approx. 23′ with 1 pipe stopper and 1 singling-out mechanism, 3 hydraulic cylinders, total weight approx. 11.000 lbs.

1.8 1 Feed Table
For pipe transport to the bevelling machine, with 8 inclined supports, length approx. 8' with one pipe ejector, one stopper and one singling-out mechanism, total weight approx. 3200 lbs.

1.9 1 Feed Table
For pipe transport to non-ferrous flange welder, with 8 inclined supports, length approx. 3', with one singling-out mechanism, one swivelling chute, one pipe pusher and one hinged bridge for pipe feeding and total 9 hydraulic cylinders, total weight approx. 2500 lbs.

1.10 1 Feed Table
Behind the non-ferrous flange welder with 8 inclined supports, length approx. 2', with one pipe stopper, total weight approx. 2646 lbs.

1.11 1 Feed Table
For pipe transport to the steel flange welder, nearly same design as described under 1.9, length approx. 13', total weight approx. 5402 lbs.

1.12 1 Feed Table
Behind the steel flange welder, same design as described under 1.10, total weight approx. 2646 lbs.

1.13 1 Feed Table
For feeding of pipes to the bend loader, item 3.8, with 8 inclined supports, length approx. 10', with 2 pipe stoppers and 2 hydraulic cylin- ders, total weight approx. 5182 lbs.

1.14 1 Feed Table
With 8 inclined supports, length approx. 5', with pipe end stoppers, total weight approx. 3308 lbs.

1.15 1 Feed Table
Same design as described under 1.14, total weight approx. 3308 lbs.

1.16 1 Feed Table
Same design as described under 1.14, total weight approx. 3308, lbs.

1.17 1 Feed Table
Same design as described under 1.14, total weight approx. 3308 lbs.

1.18 1 Feed Table
Same design as described under 1.14, total weight approx. 3308 lbs.

1.19 l.Feed Table
Arranged at the end of the chain conveyor for feeding of pipes to the bend loader, item 3.7, with 8 inclined supports, length approx. 5', with one pipe stopper and one hydraulic cylinder, total weight approx. 3400 lbs.

1.20 1 Feed Table for Short Ends
With inclined supports, length approx. 10', with pipe end stoppers, total weight approx. 3500 lbs.

1.21 1 Feed Table
For pipes 20" up to 36", pipe length approx. 20', with 6 inclined supports, length approx. 14', with singling out mechanism and hydraulic cylinder, in rigid steel construction, total weight approximately 4500 lbs.

1.22 1 Feed Table
Arranged behind the flame cutting machine with 8 inclined supports, length approx. 53' with 1 pipe ejector, 1 pipe lifting device of special design for height adaption of the feed table, 2 pipe stoppers, all mounted on steel structure elements with corrugated sheet metal covering in the hanger crane area, total weight approx, 24.095 lbs.

Item 2 Elevators Manufactured and Delivered by Oxytechnik

2.1 2 Elevators for Pipe Charging
Designed for pipe length of 20' with guiding and tracking rolls, drive by pole changeable gear motor with brake, with integrated pipe stopper with hydraulic cylinder, total weight approx. 16300 lbs.

2.2 2 Elevators for Pipe Discharging
For pipe length of 20', with one pipe stopper and one ejector each with hydraulic cylinder, further design as described under 1.3, total weight approx. 16317 lbs.

Item 3 Measuring, Sawing and End Cleaning Line Manufactured and Delivered by Oxytechnik

3.1 1 Axial Feed Conveyor
For pipe transport to the circular saw, length approx. 28′, with driven diabol rollers, chain protection and pole changeable gear motor, mounted on steel structure elements, total weight approx. 4.800 lbs.

3.2 1 Axial Feed Conveyor
Arranged behind the circular saw, length approx. 49′ for discharging of pipes of minimal length of 3.28′, with driven diabol rollers, chain protection, pole changeable gear motor, one additional gear motor, pipes in the area of the pipe and cleaner, one hydraulic cylinder, all mounted on steel structure elements, total weight approx. 6900 lbs.

3.3 1 Longitudinal Measuring Equipment
For pipe lengths of 3,28′ up to 19,685′, outfitted with digital data input by decade switches, the correct length adjustment can be read of from 5-digit indicator, total weight approx. 6.063 lbs.

3.4 1 Axial Feed Conveyor
Arranged behind the pipe and cleaner, length approx. 69′ with driven diabol rollers with one gear motor, chain protection and 6 liftable roller supports in the area of the pipe and cleaner, all mounted on steel structure elements with supports, total weight approx. 9500 lbs.

3.5 1 Band Saw
Supplied by Oxytechnik due to supplier's specification. The machine features an infinitely variable cutting speed from 16-100 MPM.

3.6 Pipe and Cleaner for Steel Pipes
The end cleaner is integrated in the axial feed conveyor with liftable roller supports according to item 3.2 and 3.4. A special brushing unit ensures cleaning of each pipe end from paint before welding.

After reaching the brushing unit the pipe transport stops and the pipe is lifted out of the axial feed conveyors by the aid of the integrated pipe rotating supports. These automatic functions are controlled via sensor lever switches. During the brushing procedure the pipe rotates with slow speed and is pressed simultaneously against the

brushes. After brushing of one pipe end the pipe is lowered onto the axial feed conveyor and further transported for brushing of the second pipe end in the same way.

Method of Operation:	automatic brushing machine with rotating brushes.
Cleaning Area:	adjustable
Drive of the Brushes:	electric motor
Control:	automatically, via sensor lever switches
Dust Filter Unit:	one piece arranged beside the cleaning device
Total Weight:	approx. 1100 lbs.

3.7 1 Bend Loader for Pipes 1" up to 4"
With gear motor, hydraulic lifting device, rails and power feeding chain, total weight approx. 2426 lbs.

3.8 1 Bend Loader for Pipes 4" up to 8" (10")
Same design as described under 2.25, total weight approx. 3528 lbs.

Item 4 Bevelling Device Manufactured and Delivered by Oxytechnik

4.1 Bevelling Machine
The bevelling machine is integrated in the roller conveyor according *to* 4.2 and consists of 2 machine bases with spindles, hydraulic feeding device, speed adjustment, hydraulically operated clamping devices, 2 bevelling heads with outside bevelling tools, 2 clamping jaws for different pipe diameters and an axial feed conveyor (described under 4.2) for pipe transporting between both bevelling heads.

The pipes can be alternatively bevelled on one or on both ends, one after the other. For this the drive of the axial feed conveyor 4.2 is outfitted with reversible gear motor.

Positioning and clamping of the pipe during the bevelling procedure:	automatically hydraulically
Adjustment of the bevelling tool according *to* the different pipe diameters:	manually by spindle
Total weight of the bevelling device (without axial feed conveyor):	approx. 2205 lbs.

4.2 1 Axial Feed Conveyor
Integrated in the bevelling machine, item 4.1, length approx. 25' with 22 liftable diabol rollers and one pipe ejector, two gear motors, chain protection, all mounted *on* steel structure elements, total weight approx. 4851 lbs.

Item 5 Electric and Hydraulic Control for Control and Operation of Items 1, 2, 3, 4 and 9

Electric and Hydraulic Control
Including switch cabinet, switch boards, approx. 350, sensor level switches, and drawings of the hydraulic circuit for customer's delivery.

Item 6 Flange Welder, Weld Neck Flanges, Manufactured and Delivered by the Supplier

Pipe welding machine for mechanical manufacturing of flanged pipes.

Without tack weld, neck weld flanges and welding neck collars can be welded to pipes on this machine which has proved itself highly satisfactory in chemical industry. The pipe flange welding machine is laid out for work pieces of the following dimensions:

Pipe nominal diameter, minimum	1 1/2"
Pipe nominal diameter, maximum	12"
Pipe length, minimum	3'
Pipe length, maximum	20'
Material	all weldable materials

After positioning, pipes and flanges are accurately fixed with clamping and centering equipment and automatically welded at high speed using the plasma/TIG process, and additional MIG is recom-

mended for multipass welding for wall thicknesses over 1/6". The tacking of the work pieces is avoided.

The equipment serves to weld automatically neck weld flanges to pipes. All weldable materials can be handled. The machine is designed as an automatic welding unit with mechanical pipe feeding and discharging. Both headstocks are equipped with a welding head as well as centering and clamping equipment. The welding process has to be observed and the welding has to be adjusted manually according to the welding procedure.

The flanges are pushed onto the centering equipment by hand or by a hoist and the pipe is positioned on the supporting rollers. After pushing "start" the centering heads move together axially and press the welding neck flanges against both ends of the pipe. The welding procedure starts automatically. Overlaps and end crater filling are pre-selected. As weld preparation and I-Joint without gap is recommended in the case of wall-thickness up to approx. 6 mm.

The machine comprises the following units:

1 machine bedplate with precision horizontal guides;
1 headstock with inside centering and clamping equipment, turning actuator as well as torch holder with lifting cylinder, sensor equipment and power transmission;
1 headstock, movable, with inside centering and clamping equipment as well as torch holder with lifting cylinder;
2 support rollers, movable, with vertical adjustment for adaption to the pipe diameter;
1 machine control, complete, comprising switch cabinet and control desk as well as the connection lines required;
2 elevators for mechanical loading of pipes.

NOTE: Welding units, as well as centering and clamping tools, are not included in the scope of delivery.

The body of the machine is of stable, rigid design welded from sectional steel. The assembly areas on the machine bedplate are machined. The

right hand side of the machine comprises a headstock with clamping equipment and turning actuator and all the equipment on the left hand side of the machine is mounted on a carriage for adaption *to* various pipe lengths. The carriage is guided on hardened, ground steel bars.

After being moved to suit the length of pipe in question, the carriage is arrested in its position.

The support rollers are set to the pertinent outside pipe diameter.

The clamping equipment is so designed that protecting gas can be supplied below the welding root. Thus, the root forms freely and pores are avoided.

On changing the flange and pipe dimensions the following adjustment and conversion work is required:

a) Adjusting the centering and clamping equipment;

b) Adjusting the support rollers to the new pipe diameter;

c) Adjusting the welding conditions such *as* power, turning speed and power downslope after overlapping. (The overlapping required is set on an impulse counter.)

Overall length	about 24′
Overall width	about 3′
Operating height	about 2,9′
Compressed air	85 psi
Total weight	approx. 3500 lbs.

Item 7 Flange Welder, Slip on Flanges Manufactured and Delivery by Oxytechnik

Nominal pipe bore min.	1 1/2″
Nominal pipe bore max.	12″
Pipe length min.	40"
Pipe length max.	20′
Flange type	slip-on
Pipe and flange material	mild steel
Flange bore	machined
Length of the machine	approx. 34,5′
Width	approx. 36″
Height (above cable carrier)	approx. 148″
Number of MIG/MAG-Welding Equipments	4 pieces
Total weight of machine (without the 4 power source)	approx 14500 lbs
Foundation	concreted work-shop floor
Total weight	approx 13670 lbs

This machine designed as a combined tacking and welding machine is highly mechanized.

The welding is done by 4 torches. A mixed gas (ARGON and C02) ensuring low sputtering is recommended as shielding gas.

Within the range of the welding seam pipes and flanges shall be cleaned to enable pore free welding. Heavy corrosion *as* well as residual grease and residual paint shall be eliminated by local grinding.

To suit the various pipe lengths the complete right-hand side of the machine is mounted on a carriage furnished with a D.C. gear motor and rack for travel purposes. This carriage makes contact with the pipe in charging position by *means* of *a* tracing device positioning the welding carriage according to pipe length.

The roller supports rotate the pipe using a variable D.C. motor. The rotation speed is adjusted at the control panel. The three-jaw chucks to take the flanges are of a design specially suited to the purposes. The jaws are driven by *a* geared motor, clutch, gear rim and thread. The design meets the requirements of the oversized jaw stroke (l″ up to 20″).

The chuck is also furnished with a slide for the centering pins to take a flange bolthole. This slide is adjusted to the diameter of the bolthole circle by means of scale and screwed spindle. The three jaws are furnished with hardened shoulders stepped to provide for the length of pipe penetration into the flange required. These jaws are to be exchanged easily.

Two elevators transport and position the pipes within the machine. The pipe is charged on *to* the elevators by mechanism being part of the supply platform, during the upward stroke. The elevators center the pipe and position it on the roller supports during the downward stroke. After welding is completed the elevators raise the pipe and permit it to roll onto a discharge platform at the front of the machine.

Remark: During the discharge procedure, only the clearance of approx. 32" width at the front of the machine is shut off for a short period by the horizontal stroke of the elevator slides.

Note: The four welding units which are not included in the scope of delivery are made available by Avondale according to Oxytechnik's specification. Additional costs for connection of the welding units to the pipe flange welding machine are included in the scope of delivery.

Production time of mechanized one layer welding of flanges *to* pipes (slip-on flanges) by the pipe flange welding machine type B using 1 operator.

Production Sequence

1. Loading of flanges manually
2. Positioning of the pipe within the machine automatically
3. Shifting flanges on pipe automatically
4. Mechanized tacking of the flanges to the pipe
5. Mechanized welding of the flanges to the pipe
6. Discharging of welded pipe.

Nominal Bore
1"
2"
3"
4"
6"
8"
10"

Item 8 Pipe Flange Tacker and Welder with Double Rotator Manufactured and Delivered by Oxytechnik

Suitable for rational tacking and semi-mechanized welding of flanges to pipe or pipe to pipe. The machine is layed out for work pieces of the following dimensions:

pipe diameter min.	10"
pipe diameter max.	36"
flange type.	slip-on flange neck weld flange
material	all weldable
pipe length min.	2'
pipe length max.	40'

Machine Characteristic Data

Overall length	approx. 52.5′
Overall width	approx. 53.2′
Overall height	approx. 56′
Service Height (dependent on pipe dia.)	approx. 26"-40"
Total machine weight	approx. 8820 lbs

The machine comprises the following equipment:

1 machine base with guide rail;
2 machine slides with horizontal guides, swivel mounted chuck and adjustment equipment for fixing the flange and mounting plate to take a wire feed unit for the MIG/MAG welder;
1 rotating device, complete, comprising 4 roll supports with twin adjustment for adaption to the pertinent pipe diameter and to compensate the offset between pipe axis and machine axis as well as 2 roll support drivers;
4 elevators for transporting and positioning of one or two pipes within the machine.

A flange is Positioned with the assistance of a hoist which takes the flange in the upper bolthole and thus brings it in front of the two centering pins in the swivel-mounted flange take-up transverse so that it can easily be set properly.

Two chucks each executing a lift/swivel motion and thus adapting automatically to each flange thickness, hold the flange rigidly in this position. This ensures that not only slip-on but also neck

weld flanges of standard steel or non-magnetic materials can be fixed.

The centering pins for taking the flanges are interchangeable and, with the assistance of a spindle with right-left handed thread, can be adjusted to the pertinent bolthole circle diameter using a scale. Interchangeable stepped shoulders adjust the distance between the end of the pipe and the flange.

Using two more spindles the flange chucking equipment is horizontally and vertically aligned with the pertinent pipe length axis.

The flange chuck equipment can be swivelled by about 30 degrees and, thus, enables a definite offset of the bolt holes of the flanges in relation *to* each other. This may be required, if the pipes are bent later, for example.

A mounting plate is additionally fitted to the adjustable slide to take the welding equipment which is not part of this standard offer.

Both machine slides can be rapidly adjusted with little strength by a handwheel for adaption to various type lengths.

The pipes are positioned by four elevators which also serve for discharging of flanged pipes. Four roll supports serve to take the pipes. Only two roll supports are driven by a D.C. motor. The roll supports can be moved lengthwise manually.

If required, two roll supports can be removed from the machine for handling short pipes to a minimum length of 2'.

After the flanges are gripped in the chucks and the pipe placed in position, the flange holders are moved together until the pipe is in contact with distance shoulders in the case of slip-on flanges. Dependent on the diameter tolerance, a gap can occur between the flange inside diameter and the pipe outside diameter. It can be equalized to improve the following welding procedure. This fine adjustment can be effected by the horizontal and vertical adjustment in the chuck slides. The wire feed unit in conjunction with a 10' torch cable now permits troubleless tacking of the flange to the pipe.

After the tacking procedure the chuck slides are moved back. The inside seam can now be welded first and the outside seam afterwards by available hand welding equipment.

Note: The surface of all large pipes (NB 20" up to 36") which are fed from the feed table 1.19 should be clean because of good welding current leakage.

Item 9 Plate Conveyor and Ejectors Manufactured and Delivered by Oxytechnik

9.3 1 Plate Conveyor
Length approx. 180', mounted on rigid steel structure elements, consisting of transporting chain, chain drives with gear motors and chain tightener, total weight approx. 15,000 lbs.

9.4 1 Pipe Ejector
Arranged above the chain conveyor, with one fixed stopper. One hydraulic cylinder, mounted on a rigid steel frame, total weight approx. 2205 lbs.

9.5 1 Pipe Ejector
Same design as described before, but equipped with one mobile pipe stopper and two hydraulic cylinders, *total* weight approx. 2,426 lbs.

9.6 1 Pipe Ejector
Same design as described under 9.5, total weight approx. 2205 lbs.

9.7 1 Pipe Ejector
Same design as described under 9.6, total weight approx. 2,426 lbs.

9.8 1 Pipe Ejector
In special design for ejecting of pipes to both sides of the chain conveyor with hydraulic cylinders, mounted on a rigid steel frame, total weight approx. 2,624 lbs.

9.9 1 Pipe Ejector
With one fixed stopper, same design as described under 9.4, total weight approx. 2,205 lbs.

Item 10 Shotblasting and Painting Equipment (Each Combined Exterior and Interior) Delivered by Oxytechnik as Well as Drawings for Roller Conveyors

10.1 1 Entrance Roller Conveyor
For transporting of pipes to external blasting, length approx. 95', outfitted with cylindrical driven rollers, chain protection, outfitted with 2 infinetively variable gear motors, width of rollers approx. 3'. For transport of single pipe being internally shotblasted or of single larger pipes each rooler is grooved in the middle.

10.2 1 Exit Roller Conveyor

Length approx. 42', outfitted with 1 infinitively variable gear motor, further design *as* described in 10.1.

10.3 1 Shotblasting machine complete for external and internal cleaning

10.3.1 External shotblasting machine, Type JET-Wheelblast Delivered from Ervin Industries

The pipes are fed automatically through the shotblasting cabin.

An interlocking system guarantees that there are no faulty controls and the equipment is only switched on when pipes are located in the blasting area of the cabin.

The machine consists of the blasting cabin with blasting medium transport system and cleaning equipment, dust extraction and filter units as well *as* switching and control desk.

The external shotblasting equipment is furnished with heavy-duty centrifugal wheels which ensure uniform transfer of the abrasive to the surface of the pipes.

Shotblasting is automatically controlled so that the blasting unit is operating only if pipes *are* in the shotblasting area. The abrasive which accrues during shotblasting is collected in the blasting medium collecting funnels. It is purified and separated from dust and dirt and again fed to the abrasive storage tank.

By using Avondale supplied pallets, fittings can be transported through the shotblasting cabinet.

10.3.2 Internal Shotblasting Machine

This machine is combined with the external shotblasting cabin which serves *as* abrasive collector and recycler. The machine consists of a roller conveyor, length approx. 25', pipe ejector, abrasive hopper with screw conveyor, mechanism for moving the shotblasting lance through the propositioned pipe and housing with lateral and axial exit.

For internal shotblasting, a single pipe located in the grooves of the roller conveyor is transported through the external shot-blasting cabin and centrally clamped by two special devices. One of them is lifted up in order to swivel the pipe to the centerline of the lance which is arranged in an inclined position above the roller conveyor 10.2. Depending on the diameter the lance will be equipped with different nozzles, diameter up to 3" venturi nozzle (air consumption - 700 CFM) diameter up to 10" radial nozzle, diameter up *to* 20" rotating nozzle (air consumption - 400 CFM). The speed of the lance is variable and the shot is transferred.

10.4 1 Entrance Roller Conveyor
Length approx. 25', same design as described in 10.2.

10.5 1 Exit Roller Conveyor
Length approx. 25', same design as described in 10.2.

10.6 2 Ejectors
Operated by hydraulic cylinders to eject pipes to the left and to the right.

10.7 1 Painting Machine Complete for External and Internal Painting

10.7.1 External Painting
The machine operates automatically. The height of the upper spraying gun is self-adjusted depending on the diameters. The spraying width is controlled according to the width of the pipe bundle. Behind the painting machine a drying cabin is arranged. A beating system can be installed later. In the drying area the pipes are moved on a slat conveyor, length approx. 25'. Paint supply and mist filter and exhaust are included.

10.7.2 Internal Painting
The internal painting lance can be located above the middle of the entrance conveyor 104. After height adjusting, depending on pipe diameter, the lance is driven through the pipe and during retracting the paint gun is operated.

EQUIPMENT PROCESSING TIMES BY PIPE DIAMETER

* TIME IN SECONDS

ITEM	OPERATION	OPERATION TIME 1-1/2"	OPERATION TIME 3-1/2"	OPERATION TIME 12"	SET-UP TIME 1-1/4"	SET-UP TIME 3-1/2"	SET-UP TIME 12"	REMARKS
1.1	Singling out & discharging	12	12	12				1 Pipe
2.2	Elevator for pipe discharging	43						Max. 10 Pipes
			68					Max. 6 Pipes
				110				Max. 1 Pipe
10.1	Entrance roller conveyor	225						Max. 10 Pipes, Rack 1
		75						Max. 10 Pipes, Rack 2
			225					Max. 6 Pipes, Rack 1
			75					Max. 6 Pipes, Rack 2
				225				Max. 1 Pipe, Rack 1
				75				Max. 1 Pipe, Rack 2
		340	340	340				From 1.1 to 10.3
10.3.1	External shotblasting	170						Max. 10 Pipes
			170					Max. 6 Pipes
				170				Max. 1 Pipe
10.2	Exit roller conveyor							1 Pipe
	still Item 1.4.1	20	20	20				
	still Item 3.1	140	140	140				
1.4.1	Discharging and singling out for internal shotblasting	24	24	24				1 Pipe
10.3.2	Internal shotblasting including discharging	280	300	360	180	190	210	1 Pipe
1.4.2	Singling out and discharging	12	12	12				1 Pipe
10.4	Entrance roller conveyor	30	30	30				
10.7.1	External painting	190	190		180	180	180	Time for changing paint not included.
				400				1 Pipe

EQUIPMENT PROCESSING TIMES BY PIPE DIAMETER

* TIME IN SECONDS

ITEM	OPERATION	OPERATION TIME 1-1/2"	OPERATION TIME 3-1/2"	OPERATION TIME 12"	SET-UP TIME 1-1/4"	SET-UP TIME 3-1/2"	SET-UP TIME 12"	REMARKS
10.7.2	Internal painting	140	190	240	900	900	900	1 Pipe - Time for changing paint not incld.
10.5	Exit roller conveyor	120	120	120				
10.6	Discharging pipes	14	14	14				
1.5	Singling out and charging pipes onto the transporting cart	17	17	17				1 Pipe
1.24	Pipe transport & discharging	125	125	125				
1.6	Singling out and charging pipes onto the roller conveyor	9	9	9				1 Pipe
3.1	Roller conveyor and length-measuring	.42	.42	.42				1 Pipe (19.7 ft.)
11.0	Pipe sawing machine	30	50	150	5	10	15	1 Pipe
3.2	Conveying and discharging still Item 1.7	10	10	10				1 Pipe
	Conveying - still Item 3.6	45	45	45				1 Pipe
1.7	Singling out and charging plate conveyor Item 9.3	20	20	20				1 Pipe
3.6	Lifting and cleaning pipes (both ends)	67 45	70 48	80 58	120	120	120	1 Pipe (19.7 ft.) 1 Pipe (3.3 ft.)
3.4	Conveying and discharging still Item 1.11	67	67	67				1 Pipe
1.8	Singling out and charging	16	16	16				1 Pipe

EQUIPMENT PROCESSING TIMES BY PIPE DIAMETER

* TIME IN SECONDS

ITEM	OPERATION	OPERATION TIME 1-1/2"	OPERATION TIME 3-1/2"	OPERATION TIME 12"	SET-UP TIME 1-1/4"	SET-UP TIME 3-1/2"	SET-UP TIME 12"	REMARKS
4.1	Bevelling both sides	200 220	240 260	260 280	240	240	280	1 Pipe (19.7 ft.) (9.8 ft.)
1.9	Singling out and charging the welding machine Item 6	35	35	35				1 Pipe
6.	Positioning, welding and discharging	90	220	800	900	900	200	GMA welding system 1 Pipe
1.10	Singling out and charging plate conveyor - Item 9.3	20	20	20				1 Pipe
1.11	Singling out and charging the welding machine Item 7	35	35	35				1 Pipe
7.	Positioning, tacking, welding & discharging pipes	120	150	360	900	900	900	1 Pipe
1.12	Singling out and charging plate conveyor - Item 9.3	20	20	20				
9:3	Transporting plate conveyor including discharging							
	from Item 1.7 to Item 1.13	87	87	87				1 Pipe
	from Item 1.7 to Item 1.19	100	100	100				1 Pipe
	from Item 1.10 to Item 1.13	58	58	58				1 Pipe
	from Item 1.12 to Item 1.13	39	39	39				1 Pipe
3.7	Pipe transport & discharging for bending	130	130	130				1 Pipe
3.8	Pipe transport & discharging for bending	110	110	110				1 Pipe

EQUIPMENT PROCESSING TIMES BY PIPE DIAMETER

* TIME IN SECONDS

ITEM	OPERATION	OPERATION TIME 1-1/2"	OPERATION TIME 3-1/2"	OPERATION TIME 12"	SET-UP TIME 1-1/4"	SET-UP TIME 3-1/2"	SET-UP TIME 12"	REMARKS
1.21	Singling out and charging pipe to the transport cart 1.25		18					1 Pipe
1.25	Pipe transport & discharging		210					1 Pipe
1.22	Singling out and charging pipes to pipe transport cart Item 1.26		20					1 Pipe
1.26	Pipe transport & discharging		110					1 Pipe
1.23	Singling out and charging welding machine - Item 8		25					1 Pipe
8.	Flange tacker and welder							1 Pipe

3.3 “T” Drill 150 and 500

“T” Drill 150

Minimum Length of Pipe 15”

Maximum Length of Pipe 21’

Existing Collaring Range 1-1/2” to 6-5/8”

Cu, CuNi, and Stainless Steel Pipe Only.

“T” Drill 500

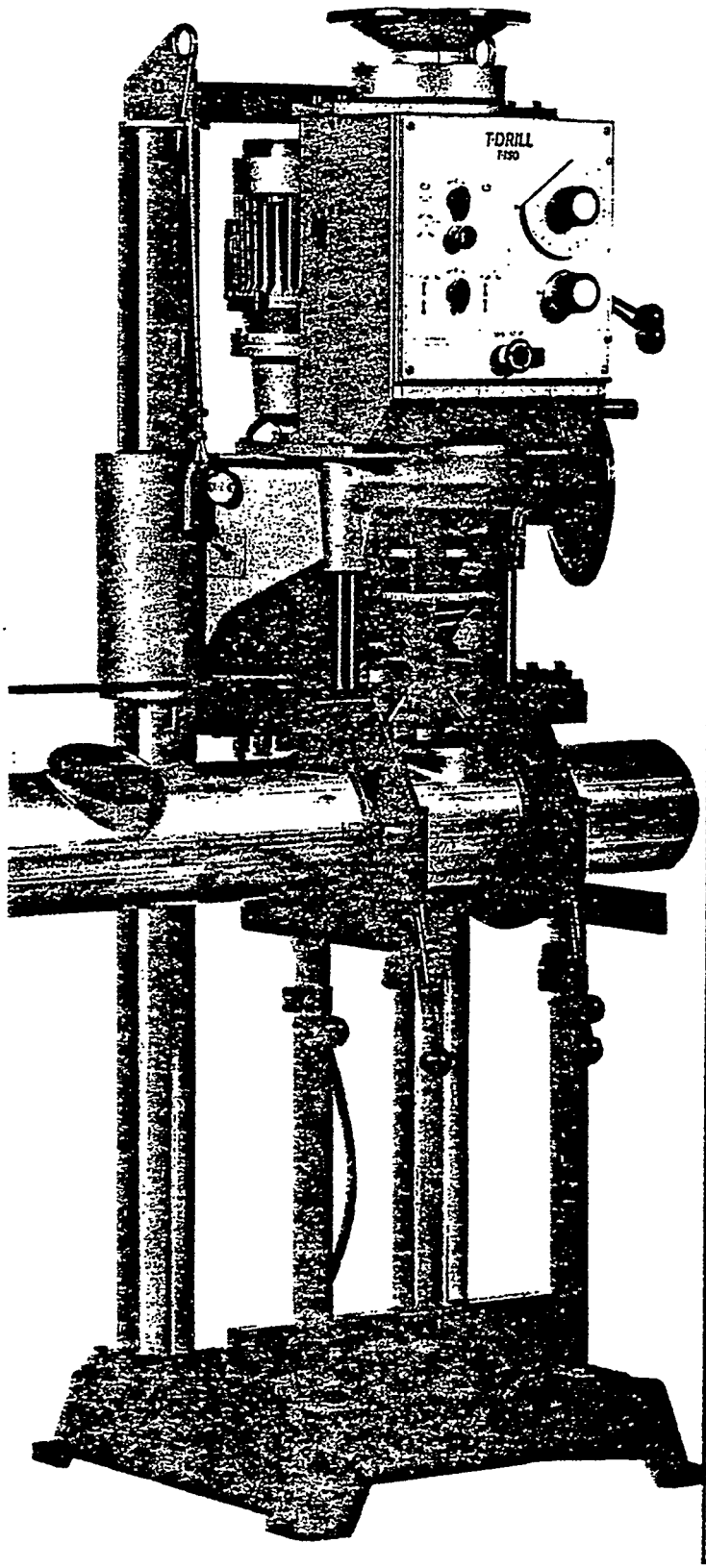
Minimum Length of Pipe 40”

Maximum Length of Pipe 21’

Existing Collaring Range 4“ to 20”

Cu, CuNi and Stainless Steel Pipe Only

T-DRILL T-150



COLLARING RANGE AND WALL THICKNESS CAPABILITY — T-150 COLLARING HEADS

Outlet O.D. D_S	Runpipe O.D. D_O	Collaring Head No.	A Mild steel		B Austenitic stainless steel		C Copper and copper alloys	
			t_{max}	h	t_{max}	h	t_{max}	h
42.4	42.4	1	2.1	2.5	2.3	2.5	2.3	2.5
	48.3	1	2.3	3	2.5	3	2.5	3
	60.3	1	2.5	3	2.7	3.5	2.7	3.5
	76.1	1	2.6	4	2.7	4	2.7	4
	88.9	1	2.9	4.5	3.0	4.5	3.0	4.5
48.3	48.3	1	2.6	3	2.7	4	2.6	3.5
	60.3	1	2.9	3.5	3.2	3.5	3.0	3.5
	76.1	1	2.9	4	3.6	4	3.2	4
	88.9	1	3.2	4.5	3.6	5	3.5	5
	219.1	1 or 2	3.2	4.5	3.6	5	3.5	5
60.3	60.3	2	2.9	3.5	3.2	3.5	3.2	3.5
	76.1	2	3.2	4	3.6	4	3.6	4
	88.9	2	3.6	5	4	5	4	5
	114.3	2	4	6	4.5	6	4.5	6
	139.7	2	4.5	6	4.5	6	4.5	6
76.1	76.1	2a	3.6	4.5	4	4.5	4	4.5
	88.9	2a	3.6	5	4.5	5	4.5	5
	114.3	2a	4.5	6	5	6	5	6
	139.7	2a	5	6	5	7	5	7
88.9	88.9	2a	4	5	3.6	5	4.5	5
	114.3	3	5	6	5	6	5	6
	139.7	3	5.6	7	5.6	7	5.5	7
114.3	114.3	4	4.5	6	3.6	5	4.5	6
	139.7	4	5.6	7	4.5	7	5.5	7
	168.3	4	6.3	7	5	7	6	7
	219.1	4	6.3	8	5.6	8	6	8
139.7	139.7	5	4.2	7	3.5	7	4	7
	168.3	5	5	7	4	7	5	7
	219.1	5	5.6	8.5	4.5	8.5	5.5	8.5
	273	5	5.6	10	5	10	5.5	10
168.3	168.3	5	3.8	6	3.2	6	4	6
	219.1	5	4.8	8.5	4	8.5	5	8.5
	273	5	5.6	10	4.5	10	5	10

ACTUAL PROPERTIES OF MATERIALS

A Mild steel
- elongation to fracture about 30% or better (22% to 25% in material codes)
- yield strength about 300 N/mm² (43500 psi) or lower (200 to 250 N/mm²; 29000 to 36000 psi in material codes)

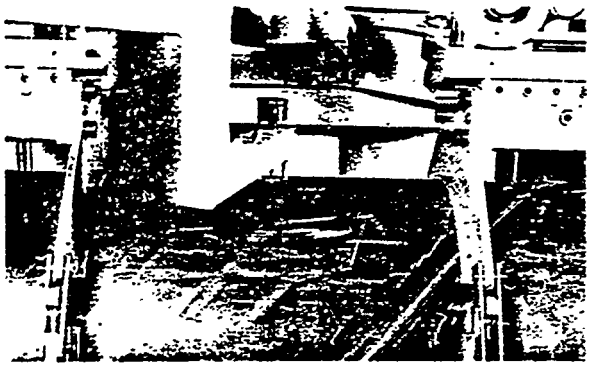
B Austenitic stainless steel
- elongation to fracture about 45% or better (in material codes 35% to 40%)
- yield strength about 250 N/mm² (36000 psi) or lower (about 200 N/mm²; 29000 psi in material codes)

C Copper and copper alloys
- elongation to fracture about 35% or better (in material codes 27% to 30%)
- yield strength about 250 to 300 N/mm² (36000 to 43000 psi) or lower (in material codes 250 N/mm²; 35000 psi)

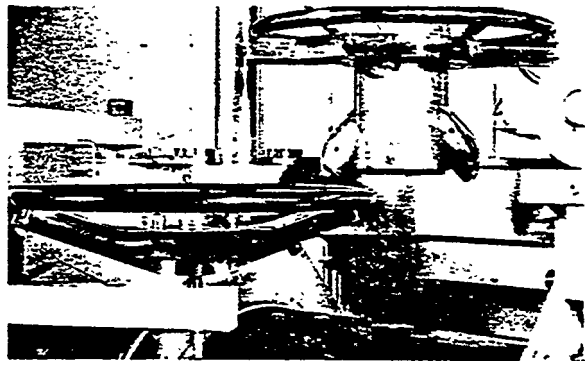
PRECISION BUTT WELD COLLARS IN ONE SETUP

T-DRILL: STEPS OF OPERATION

In the illustrations there is shown model T-500 — the principle is similar to the T-150.

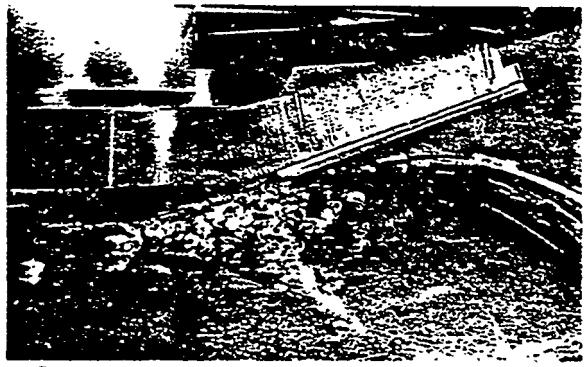


1 *A pipe section is secured by means of quick-acting ring clamps and is positioned to a mark.*

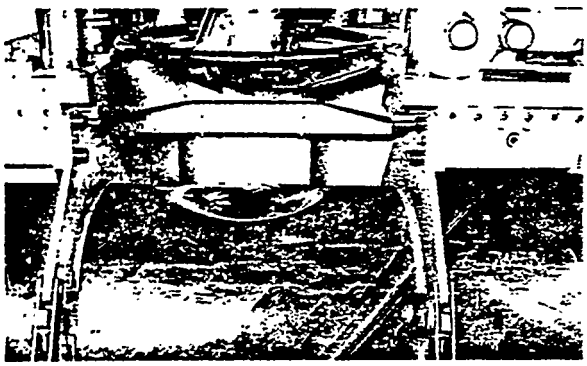


2 *Elliptical pilot hole cutter is fitted.*

3 *Pilot hole dimensions and cutting speed are controlled by dial settings.*

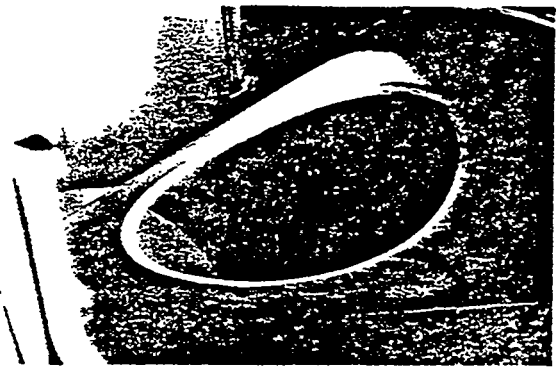


4 *As the cutting angle is conical, a range of sizes can be cut with each tool.*



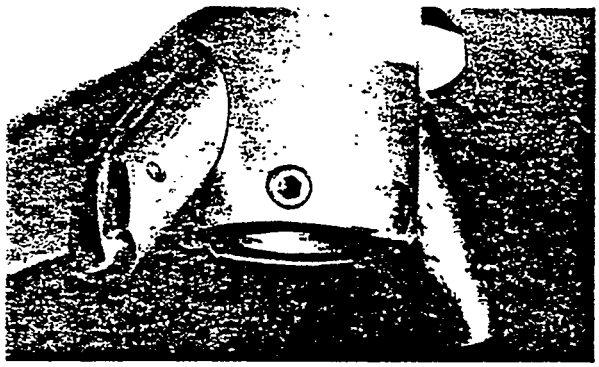
5 *Pilot hole after machine cutting.*

6 *The operator performs a minor deburring operation on the edge of the hole.*



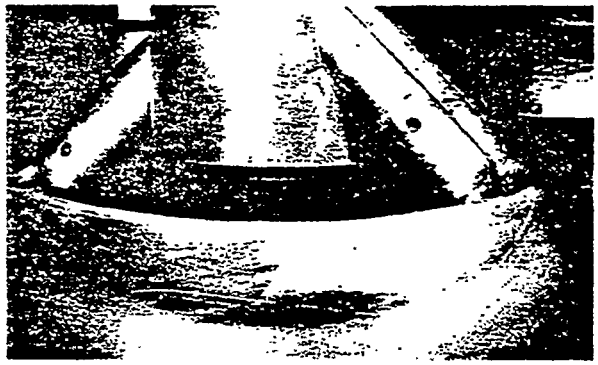
7 *Deburred pilot hole.*

8 *Collaring head is a tool which forms the collar.*

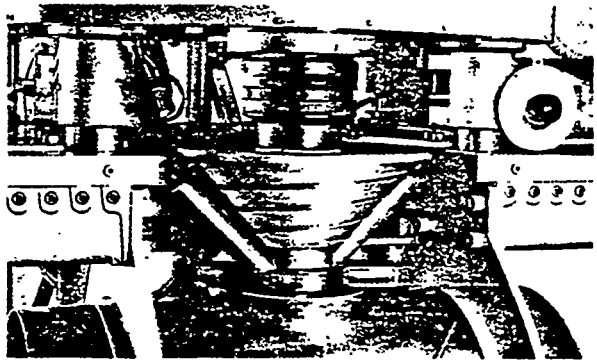


9 *Collaring head inserted into pipe through a pilot hole. Forming pins are extended to a preset dimension.*

10 *The machine forms the collar by rotating the collaring head simultaneously outwards through the pilot hole.*



11 *During the collaring lubrication compound is applied onto the forming pins.*

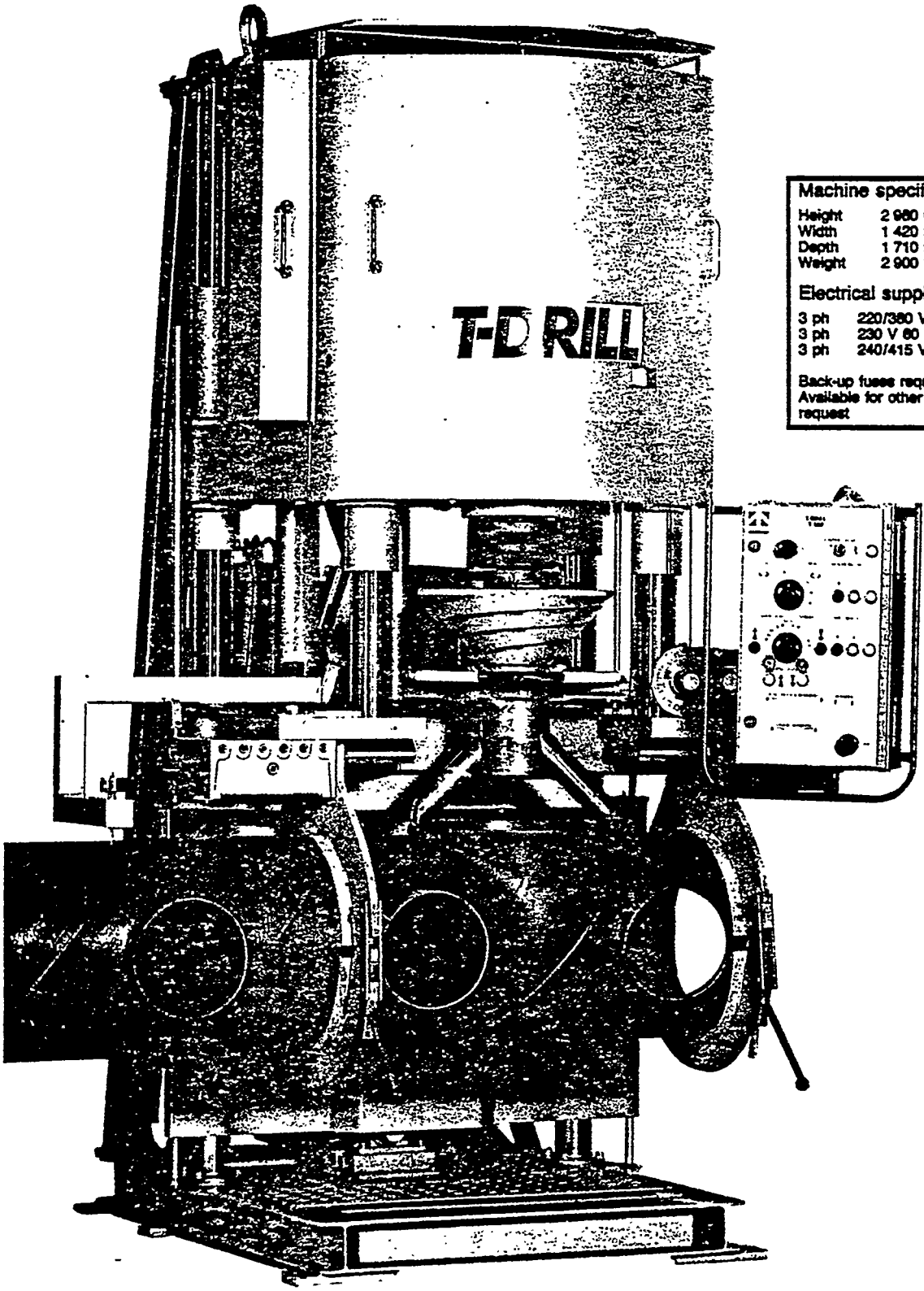


12 *With no change of tooling the machine mills the collar rim to the required final height.*

13 *Chamfer device can be used to bevel the collar rim to the required weld preparation angle.*

14 *The collar is ready for butt welding.*

T-DRILL T-500



Machine specification

Height	2 960 mm
Width	1 420 mm
Depth	1 710 mm
Weight	2 900 kg

Electrical supply

3 ph	220/380 V 50 Hz
3 ph	230 V 60 Hz
3 ph	240/415 V 50 Hz

Back-up fuses required 3 x 35 A
Available for other voltages upon request

3.4 Pipe Rack and Feed Table Loading

Pipe Rack Storage Capacity

2 - Pipe Racks in Position 1.3 (1-1/1" to 12″)

Loading Of One Typical Pipe Rack

First Floor Level	= 97 1-1/2" Pipes
Second Floor Level	= 97 1-1/2" Pipes (or) 47 1-1/2" and 39 2" Pipes
Third Floor Level	= 78 2" or 64 2-1/2" Pipes (or) 39 2" and 32 2-1/2" Pipes
Fourth Floor Level	= 65 2-1/2" or 53 3" Pipes (or) 32 2-1/2" and 26 3" Pipes
Fifth Floor Level	= 53 3" or 46 3-1/2" Pipes (or) 26 3" and 23 3-1/2" Pipes
Sixth Floor Level	= 46 3-1/2" or 41 4" Pipes (or) 23 3-2/3" and 20 4" Pipes
Seventh Floor Level	= 41 4" or 33 5" Pipes (or) 20 4" and 16 5" Pipes
Eighth Floor Level	= 33 5" or 27 6" Pipes (or) 16 5" and 13 6" Pipes
Ninth Floor Level	= 27 6" *or* 21 *8″* Pipes (or) 13 6" and 10 8" Pipes
Tenth Floor Level	= 21 8" or 17 10" Pipes (or) 10 8" and 8 10" Pipes
Eleventh Floor Level	= 17 10" or 14 12" Pipes (or) 8 10″ and 7 12″ Pipes

A. One Rack 478 Two Racks 956	one diameter loaded on each floor
* In pipe size 1-1/2"	to 12″
B. One Rack 525 Two Racks 1050	50/50 diameter mix on each floor
* In pipe size 1-1/2"	to 12″

Two weeks (10 days) supply at 150 Spools per day (one 20′ pipe equals to two spools) requires 750 20′ pipes in racking system.

1 - Feed Table in Position 1.1 (14″ to 20″)

Choice of the following:

1. 11 14″ Pipes (or) 5 14″ and 4 16″
2. 9 16″ Pipes (or) 4 16″ and 4 18″
3. 8 18″ Pipes (or) 4 18″ and 3 20″
4. 7 20″ Pipes

1 - Feed Table in Position 1.21 (20″ to 36″)

Choice of the following:

1. 7 20″ Pipes (or) 3 20″ and 3 22″
2. 6 22″ Pipes (or) 3 22″ and 3 24″
3. 6 24″ Pipes (or) 3 24″ and 2 26″
4. 5 26″ Pipes (or) 2 26″ and 2 28″
5. 5 28″ Pipes (or) 2 28″ and 2 30″
6. 5 30″ Pipes (or) 2 30″ and 2 32″
7. 4 32″ Pipes (or) 2 32″ and 2 34″
8. 4 34″ Pipes (or) 2 34″ and 2 36″
9. 4 36″ Pipes

3.5 Bending Equipment

Bending equipment specifications are two lengthy for inclusion within this document. Details are obtainable by contacting the suppliers.

The CONRACT Bender and the Schwrze-Wirtz Bender both are equipped with CNC capability and are designed for 2 times the diameter bends. Additionally, the machines are capable of bending pipe with or without flanges.